Mohill Renewable Energy Feasibility Study

Prepared for:

Western Development Commission

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Global Green Sustainability
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Document Lead Sheet

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Executive Summary

Energy represents a big challenge for future generations; not only mineral and fossil energy sources are being exhausted, but also GHG emissions pollute the environment and disrupt life natural cycles bringing serious irreversible impacts on earth.

Renewable energy sources, on the other hand, are unexhausted and free of pollution. They play an important role in the generation of clean energy. Renewable Energy Systems have other beneficial features, for example low running cost, long lifetime and silent non-polluting energy generation. Given the recent increasing public focus on climate change issues, there is a need for robust, sustainable and climate friendly power transmission and distribution systems that are smart, reliable, and green.

Current power systems create environmental impacts as well as contributing to global warming due to their utilisation of fossil fuels, especially coal, as carbon dioxide is emitted into the atmosphere. In contrast to fossil fuels, renewable energy is starting to be used as the panacea for solving climate change or global warming problems.

This Renewable Energy Feasibility Study was undertaken to investigate the potentialities of renewable energy for the following locations in Mohill, Co. Leitrim;

1. **Mohill Enterprise Centre and grounds**
2. **Mohill Family support Centre**
3. **Eivers Lane Childcare**
4. **Reynolds Topline**
5. **Baxter Centra**
6. **Modular Systems**
7. **Old VEC Building**
8. **New Community School**
9. **Aurivo – Mohill Mart**
10. **Lough Rynn Hotel**
11. **McCawley wood fuels: potential use of wood chips to offset oil use in Mohill**

The renewable energy technologies that were investigated as part of this feasibility study were as follows; Bioenergy, Wind, Solar PV, Solar hot water, Heat pumps, and Hydro.

Recommendations and calculations are based on rigorous energy simulation assessment and expert knowledge.

Each method of microgeneration is circumstance specific, as no one technique will be suitable for every business/building. Issues such as the size and location of the building, occupational patterns, energy demand, design and construction will combine to determine which the best renewable energy source is.

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1 Introduction

Energy represents an important input in our everyday life. It has been forecasted by the International Energy Agency (IEA) committee of energy research and technology that, "by year 2050 the global energy demand will double", and since even oil industry lobbyists admit that the age of mineral oil may last for only a few decades, it is for us to find energy technology alternatives to balance the incoming energy shortages.

The process of managing energy is not new or complicated. Energy should be treated as a controllable cost with resources allocated to a strategic approach that should be appropriate to the size of energy expenditure and the likely savings based on the current levels of efficiency.

In order to perform an evaluation of the different energy systems' technical performance, various parameters values were collected. Information regarding the technical systems' efficiencies, power, performance, payback, size and lifetime were examined. Depending on the type of system, there are different parameters of interest.

2 Context

2.1 Drivers for Better Energy Performance

Effective energy management can result in the following benefits for the organisation:

- **Annual cost savings**
- **A reduced carbon footprint**
- **Increased knowledge of energy and environmental issues among management and staff**
- **Enhanced business credentials**

3 Economics of Renewable Energy

Where the reduction of carbon emissions is a significant consideration, an understanding of the economics of renewable energy is needed, in order to maximise the carbon savings per euro spent. Equally, it is helpful if renewable energy systems (or Low and Zero Carbon Technologies) provide heat or electricity more cheaply than other options.

In making an economic case for renewable energy systems, the following issues would need to be considered:

- **Capital costs**
- **Revenue benefit resulting from avoidance of conventional fuel, taking into consideration the usage patterns of the hall and how these map onto renewable resource availability**
- **Revenue cost of fuel used by the system**
- **Ongoing maintenance and management costs**
- **Payback period**

In addition to emission reductions, there are a range of other benefits to take into account – including the provision of improved comfort conditions; and providing an educational resource for the community and sense of involvement in the environmental agenda.

The following technologies were considered for each business/building: wind; solar; biomass; hydro and Heat Pumps.

Others are only considered if applicable. Combined heat and power (CHP) is not regarded as a relevant technology for most businesses for a number of reasons: the carbon reductions arising from domestic scale micro-CHP are unproven; smaller biomass CHP systems are highly challenging; and even larger systems (e.g. for large buildings) need a significant year-round heat load to be viable. Accordingly CHP is outside the scope of this report.

4 Renewable Energy Financial Incentives

The following financial incentives are available for Renewable Energy Projects in businesses:

a) Accelerated Capital Allowances (ACA)

The ACA is available to companies and other trading structures who invest in energy efficient and renewable energy equipment. This measure allows the purchaser to write off 100% of the purchase value of qualifying equipment against profits in the year of purchase. For further information: https://www.seai.ie/energy-in-business/accelerated-capitalallowance

b) SEAI's Better Energy Community Programme – up to 30% Capital Funding

The SEAI BEC Programme offers grant aiding for projects including businesses. In many cases, local businesses can act as catalysts for Better Energy Community projects, often sponsoring the community element of a project. Up to 30% capital grant funding is available.

c) Support Scheme Renewable Heat - The installation grant provides funding of up to 30% of eligible costs

The Support Scheme for Renewable Heat is a government funded initiative designed to increase the energy generated from renewable sources in the heat sector. The scheme is open to commercial, industrial, agricultural, district heating, public sector and other non-domestic heat users. The Scheme aims to; Bridge the gap between the installation and operating costs of renewable heating systems and the conventional fossil fuel alternatives; and Incentivise the development and supply of renewable heat. The Scheme will support;

- **An installation grant**
- **On-going operational support**

The grant to support investment in renewable heating systems that use the following technologies is now being offered:

- **Air source heat pumps**
- **Ground source heat pumps**
- **Water source heat pumps**

Biomass boilers or biomass HE CHP heating systems; and Biogas (anerobic digestion) boiler or biogas HE CHP heating systems are expected to be supported this year.

The scheme is aimed at reducing energy costs and will have a huge impact on margins and competitiveness in businesses. Designed to contribute to Ireland meeting 2020 renewable energy targets, the Support Scheme for Renewable Heat will consist of two types of support mechanisms: An ongoing operational support (paid for up to 15 years) for new installations or installations that currently use a fossil fuel heating system and convert to using biomass heating systems or anaerobic digestion heating systems.

A grant (of up to 30%) to support investment in renewable heating systems that use heat pumps. The maximum tariffs paid will be 5.6 cents per kilowatt hour of energy produced from biomass heating systems. The tariffs paid will reduce with increasing output reflecting the economy of scale associated with larger system.

Tier	Lower Limit (MWh/yr)	Upper Limit (MWh/yr)	Biomass Heating Systems Tariff (c/kWh)
1	0	300	5.66
2	300	1,000	3.02
3	1,000	2,400	0.50
4	2,400	10,000	0.50
5	10,000	50,000	0.37
6	50,000	N/A	0.00

All the calculations and figures within this report are excl. capital grant funding unless otherwise stated.

5 Mohill Enterprise Centre


Mohill Enterprise Centre have a computer training suite, office space and industrial space for businesses to hire.

5.1 Introduction to Renewable Energy

Renewable energy systems are those that tap into the Earth's natural cycles to generate heat or electricity. They do not include fossil fuels (although these are derived from plant matter and, therefore, the sun), but do include biomass (such as timber and energy crops).

5.2 Significant Energy Users

Significant energy users (SEUs) are a key characteristic of energy performance. All types of energy consumed and energy-using plant, equipment, fixtures and fittings within the business were investigated. The different categories of plant and equipment that use energy were identified.

The Significant Energy User categories identified were as follows;

- **Heating**
- **Lighting**
- **Information Technology (IT)**

The building is heated through Storage Heaters which utilise night rate electricity.

5.3 Current Energy Use and Costs

The annual energy use and costs for the Mohill Enterprise Centre are as follows;

Energy Type	kWh / Annum	Cost (ex VAT)
Electricity	42,000	€6,000

5.4 Opportunities for Renewable Energy

The purpose of this Renewable Energy Feasibility Study was to analyse the effectiveness of technologies related with the production of renewable energy. The goal of this Feasibility Study was to determine which technologies would be more feasible to apply at Mohill Enterprise Centre to reduce energy costs and GHG emissions.

The analysis consisted of defining the property, functioning and energy output of each renewable energy technology. From an analysis of the potential renewable energy technologies that would be best suited to Mohill Enterprise Centre the following are the Renewable Energy opportunities;

The renewable energy technologies identified were;

- **Solar PV**
- **Micro Wind Gneration**

5.4.1 SOLAR PV

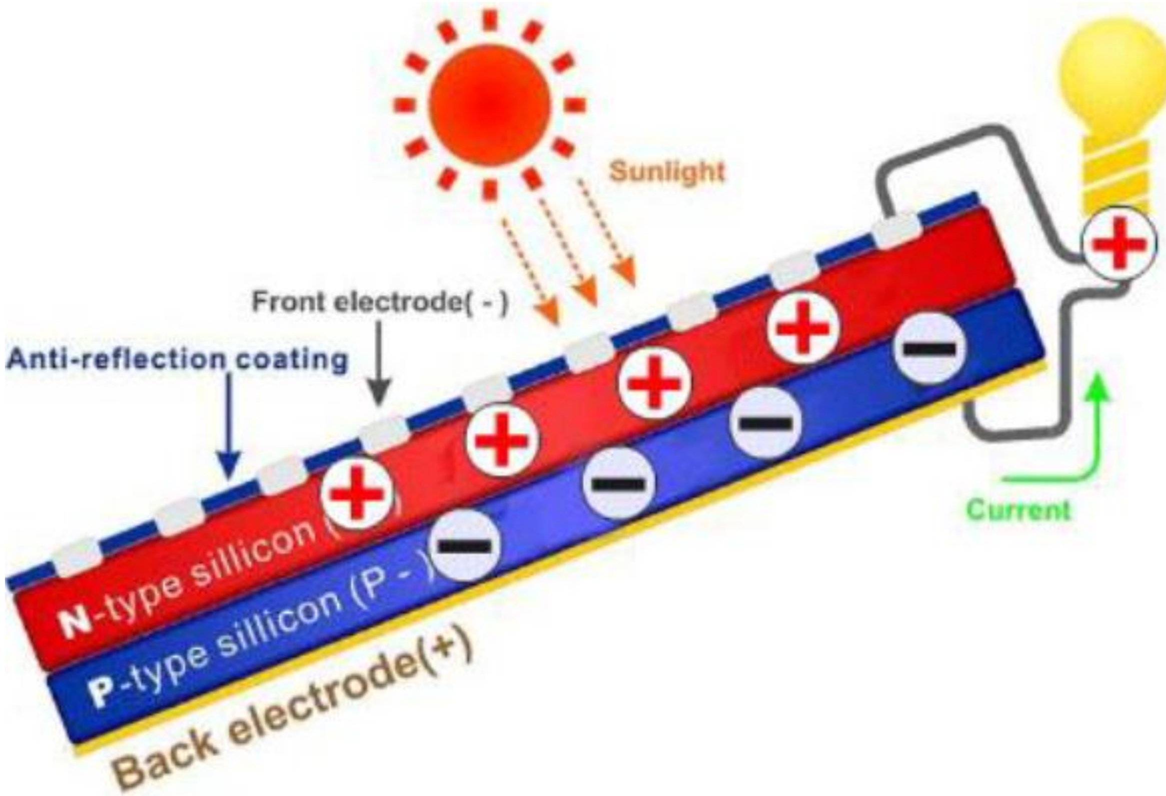
5.4.1.1 BACKGROUND

The sun provides free renewable energy, which makes it one of the most cost-effective solutions compared to traditional resources, such as coal, oil or nuclear power. Furthermore, the sun represents an inexhaustible energy source. Solar energy technologies are characterised by such beneficial features as low running cost, long lifetime, and silent non-polluting energy generation.

Energy from the sun can be harnessed during daylight hours to generate heat or power. Cloud cover does not stop solar energy collection, but at any given moment energy collection is maximised when cloud cover is low, the angle of the sun is high, and the collector is oriented so that it faces the sun. Solar energy is collected and converted using a limited number of broad principles – although there are many variations associated with each.

A photovoltaic or PV module is commonly made from a number of cells connected to-gether in series. In accordance with the spectrum of available light, various materials display varying efficiencies. Therefore, depending on the manufacturing material solar modules are optimised for light absorption prior or beyond the Earth's atmosphere.

Solar panels use light energy from the sun to generate electricity through the photovoltaic effect. Photovoltaic modules or solar panels are made from semiconductor materials, such as silicon. Impurities are added to simulate a doping effect and increase the number of charge carriers within the semiconductor material. When impurities are added, two different layers are created: one of n-type material, which has too many electrons, and one of p-type material, which has too few. Junction between the two layers is known as a p-n junction. This technique is used to manufacture transistors and integrated circuits (silicon chips).



Light consists of packets of energy called photons. Depending on their wavelength, photons are either reflected or absorbed. The energy from the absorbed photons is given to the electrons in the material, which causes some of them to cross the p-n junction. Both cell sides must be connected in order to get a current flow. Current is proportional to the number of absorbed photons and therefore proportional to the light intensity.

5.4.1.2 MOHILL ENTERPRISE CENTRE SOLAR PV OPPORTUNITY

The building is ideally orientated with a south facing roof for a roof mounted solar array. There is also ample space to the south for a ground mounted solar array. The principle of achieving a net zero energy building using solar energy will require some tariff to sell export power, as it would not be feasible to match the on-site demand on a seasonal basis. Therefore, for now we will assume that an appropriate export tariff exists, but that systems to optimise on-site use will be prioritised.

To convert solar energy to electricity, photovoltaic cells are used. These are currently manufactured from high grade silicon wafer: as such, they are still expensive to produce, and the conversion efficiency does not tend to be far above 10%.

36 x 300w Solar PV on one roof space with a total output of 10.8kWp. Battery storage to be incorporated as this will improve the efficiency as the weekend energy can be stored and used during the peak hours during weekdays.

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
11kW Roof Mounted excl. battery storage	36	300	50.00	10.80	€10,626	9112	€1,458	7.3

Item	Annual Savings (€)	Investment (€)	ROI (Years)
11kW Solar PV incl battery storage	1,900	27,500	14.5

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
Solar PV Car Park	60	295	99	17.70	€20,355	14,933	€2,389	8.5

All figures are excl. VAT and capital funding support. Figures include supply & fit and all associated works required.

5.4.1.3 TIMEFRAMES

Typically, the timeframe for completing a Solar PV of less 11kW is 4 weeks. For the Solar PV Car Park, the project timeframe is increased due to planning and also the larger scale of the project. Generally, a valid application will be dealt with by a planning authority in 12 weeks from the date the application is made to the final grant of a permission. However, the period can vary, particularly if the planning authority seeks further information from the applicant (which it should do within the first 8 weeks).

Therefore, the full project would be expected be circa. 20 weeks.

5.4.1.4 PLANNING IMPLEMENTATIONS

For the roof mounted Solar PV opportunity no planning permission is exempt. Any commercial solar system with a footprint of less than 50 m2 is deemed planning exempt in the Republic of Ireland.

For the Solar PV Car Park a Landscape Character Assessment could possibly be required due to the location of the panels to the neighboring housing stock.

5.4.2 MICRO WIND TURBINE

Wind can be used to generate electricity for power consuming appliances – with or without grid connection – or it can be used to heat a thermal store. In general, best value can be obtained through generating electricity.

Very small turbines (~1kW) can sometimes be mounted on buildings, but wind turbine siting guidelines generally recommend that to avoid turbulence, turbines should be 10m or higher than surrounding physical objects, including the object or ground below. Thus, the output from building mounted turbines is likely to be less than their small rating suggests. Ideally, therefore, turbines should be mounted on tall masts, in open ground with good separation from physical obstacles (walls, trees, etc.) especially in an upwind direction. Wind turbine technology is highly scalable, with many variants manufactured so far at scales from the very small to the very large.

There are also a great many practical and planning constraints which must be considered in some detail before erecting a turbine (especially a larger one), and the relevant planning office should be consulted about this. Issues include:

- **Noise impacts**
- **Landscape and visual impact**
- **Impact on microwave communications, RADAR, etc.**
- **Ground conditions or building structure**
- **Transport and access for turbines and construction equipment**
- **Site ecology.**

Description	Tower Height (m)	Total System Size (kW)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI (Years)
5kW Wind Turbine	10	5	€19,950	12,500	€2,125	9.4

6 Mohill Family Support Centre

Mohill Family Support Centre provides support services for the local community and facilitates activities, classes and groups in the hall.

6.1 Introduction to Renewable Energy

Renewable energy systems are those that tap into the Earth's natural cycles to generate heat or electricity. They do not include fossil fuels (although these are derived from plant matter and, therefore, the sun), but do include biomass (such as timber and energy crops).

The following technologies were considered for Mohill Family Support Centre: Bioenergy, Solar PV, and Heat pumps. Others are only considered if applicable.

6.2 Significant Energy Users

Significant energy users (SEUs) are a key characteristic of energy performance. All types of energy consumed and energy-using plant, equipment, fixtures and fittings within the business were investigated. The different categories of plant and equipment that use energy were identified.

The Significant Energy User categories identified were as follows;

- **Heating**
- **Lighting**
- **Information Technology (IT)**

The building is heated through an oil-fired boiler with radiators throughout the building.

6.3 Current Energy Use and Costs

The annual energy use and costs for the Mohill Family Resource Centre is as follows;

Energy Type	kWh / Annum	Cost (ex VAT)
Electricity	12,600	€2,142
Oil (Kerosene)	31,446	€2,751

6.4 Opportunities for Renewable Energy

The purpose of this Renewable Energy Feasibility Study was to analyse the effectiveness of technologies related with the production of renewable energy. The goal of this Feasibility Study was to determine which technologies would be more feasible to apply at Mohill Enterprise Centre to reduce energy costs and GHG emissions.

The analysis consisted of defining the property, functioning and energy output of each renewable energy technology. From an analysis of the potential renewable energy technologies that would be best suited to Mohill Enterprise Centre the following are the Renewable Energy opportunities;

The renewable energy technologies identified were;

- **Solar PV**

The opportunities for renewable energy are very limited for the Family Resource Centre. It is an old building with solid wall construction and little or no insulation. Substantial work would have to be completed to bring the building up to a standard for a Heat Pump.

The south facing roof has a lot of over shading from the neighboring mature trees as show in the photo below;

Space is limited on the site for Biomass storage. The best option would be either small scale solar and to connect in with a district heating system as discussed later in this report.

6.4.1 SOLAR PV

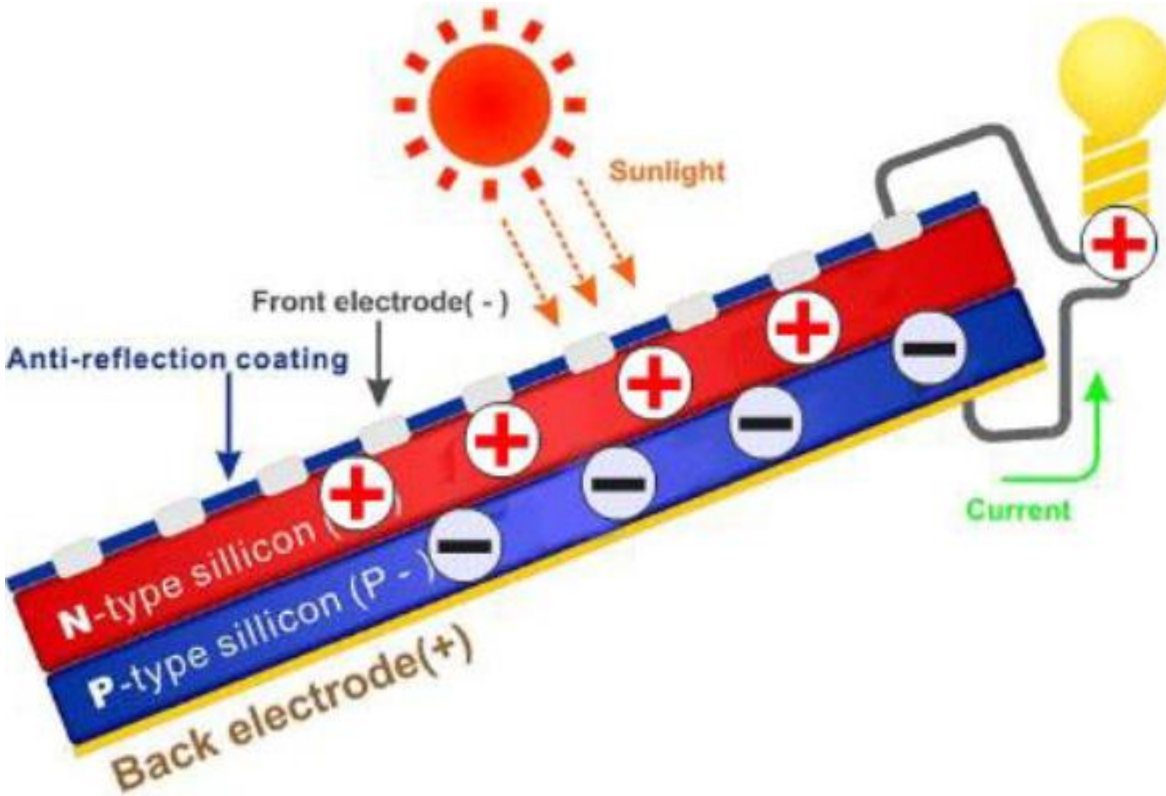
6.4.1.1 BACKGROUND

The sun provides free renewable energy, which makes it one of the most cost-effective solutions compared to traditional resources, such as coal, oil or nuclear power. Furthermore, the sun represents an inexhaustible energy source. Solar energy technologies are characterized by such beneficial features as low running cost, long lifetime, and silent non-polluting energy generation.

Energy from the sun can be harnessed during daylight hours to generate heat or power. Cloud cover does not stop solar energy collection, but at any given moment energy collection is maximised when cloud cover is low, the angle of the sun is high, and the collector is oriented so that it faces the sun. Solar energy is collected and converted using a limited number of broad principles – although there are many variations associated with each.

A photovoltaic or PV module is commonly made from a number of cells connected to-gether in series. In accordance with the spectrum of available light, various materials display varying efficiencies. Therefore, depending on the manufacturing material solar modules are optimised for light absorption prior or beyond the Earth's atmosphere.

Solar panels use light energy from the sun to generate electricity through the photovoltaic effect. Photovoltaic modules or solar panels are made from semiconductor materials, such as silicon. Impurities are added to simulate a doping effect and increase the number of charge carriers within the semiconductor material. When impurities are added, two different layers are created: one of n-type material, which has too many electrons, and one of p-type material, which has too few. Junction between the two layers is known as a p-n junction. This technique is used to manufacture transistors and integrated circuits (silicon chips).



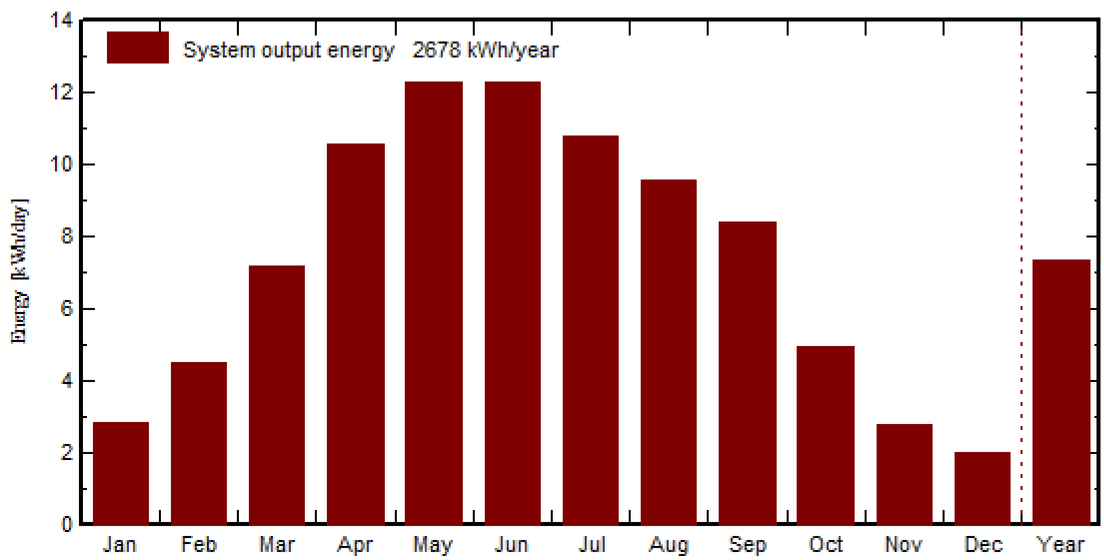
Light consists of packets of energy called photons. Depending on their wavelength, photons are either reflected or absorbed. The energy from the absorbed photons is given to the electrons in the material, which causes some of them to cross the p-n junction. Both cell sides must be connected in order to get a current flow. Current is proportional to the number of absorbed photons and therefore proportional to the light intensity.

6.4.1.2 SOLAR PV OPPORTUNITY

The building is ideally orientated with a south facing roof for a roof mounted solar array. However, the roof space has got shading from nearby trees which will reduce the Solar PV Generation capacity. The principle of achieving a net zero energy building using solar energy will require some tariff to sell export power, as it would not be feasible to match the on-site demand on a seasonal basis. Therefore, for now we will assume that an appropriate export tariff exists, but that systems to optimise on-site use will be prioritised.
The centre is used mostly during the week however the centre is used in-frequently during weekends for events and activities.

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
6kW Roof Mounted	20	295	33	5.90	€5,805	2678	€428	13.5

All figures are excl. VAT and capital funding support. Figures include supply & fit and all associated works required.



	Gl. horiz. kWh/m².day	Coll. Plane kWh/m².day	System output kWh/day	System output kWh
Jan.	0.61	1.24	2.83	88
Feb.	1.22	1.97	4.51	126
Mar.	2.26	3.11	7.13	221
Apr.	3.83	4.60	10.54	316
May	4.98	5.36	12.29	381
June	5.20	5.34	12.26	368
July	4.47	4.69	10.76	333
Aug.	3.76	4.17	9.56	297
Sep.	2.79	3.65	8.37	251
Oct.	1.42	2.14	4.92	152
Nov.	0.67	1.21	2.77	83
Dec.	0.41	0.86	1.97	61
Year	2.64	3.20	7.34	2678

6.4.1.3 TIMEFRAMES

Typically, the timeframe for completing a Solar PV of less than 11kW is circa. 4 weeks.

6.4.1.4 PLANNING IMPLEMENTATIONS

For the roof mounted Solar PV opportunity planning permission is exempt. Any commercial solar system with a footprint of less than 50 m2 is deemed planning exempt in the Republic of Ireland.

7 Eivers Lane Childcare

Eiverslane Childacre is a childcare facility for the local community. It consists of a full day care service catering for children 5 months up to 12 years. The service provides care for a maximum of 3 babies, 10 wobblers, 12 toddlers, 16 play schools, 66 pre-school and 30 after school children per session.

7.1 Introduction to Renewable Energy

Renewable energy systems are those that tap into the Earth's natural cycles to generate heat or electricity. They do not include fossil fuels (although these are derived from plant matter and, therefore, the sun), but do include biomass (such as timber and energy crops).

The following technologies were considered for Eivers Lane Childcare Centre: Bioenergy and Heat pump. Others are only considered if applicable. Solar PV wouldn't be suitable as there is a lot of shading from trees to the side of the building.

7.2 Significant Energy Users

Significant energy users (SEUs) are a key characteristic of energy performance. All types of energy consumed and energy-using plant, equipment, fixtures and fittings within the business were investigated. The different categories of plant and equipment that use energy were identified.

The Significant Energy User categories identified were as follows;

- **Heating**
- **Lighting**

The building is heated through an oil-fired boiler with underfloor heating throughout the building.

7.3 Current Energy Use and Costs

The annual energy use and costs for Eivers Lane Childcare are as follows;

Energy Type	kWh / Annum	Cost (ex VAT)
Electricity	26,470	€4,500
Oil (Kerosene)	14,860	€2,600

7.4 Opportunities for Renewable Energy

The purpose of this Renewable Energy Feasibility Study was to analyse the effectiveness of technologies related with the production of renewable energy. The goal of this Feasibility Study was to determine which technologies would be more feasible to apply at Eivers Lane Childcare Centre to reduce energy costs and GHG emissions.

The analysis consisted of defining the property, functioning and energy output of each renewable energy technology. From an analysis of the potential renewable energy technologies that would be best suited to building, the following are the Renewable Energy opportunities;

The renewable energy technologies identified were;

- **Air to Water Heat Pump**

The building has had previous energy efficiency measures completed, eg. Insulation and Lighting. The air to water is the most suitable renewable technology as the site is limited in space and the roof isn't south facing, there is a lot of shading from the neighbouring mature trees also.

7.4.1 AIR TO WATER HEAT PUMP

Eivers Lane Childcare is currently heated through an oil boiler, this is an old oil boiler. There is an underfloor heating system in the building.

The most efficient and reliable solution for heating the Childcare Centre would be an air to water heat pump. Air-to-water heat pumps, due to their ease and low cost of installation, are both economically viable and environmentally friendly as a renewable alternative to traditional heat generators. With oil prices expected to increase continuously the heat pump will save further in this respect and with the reduced maintenance costs compared to the oil boiler this will shorten the payback period also.

Underfloor heating reduces the energy consumption required for space heating by using low water temperatures to heat the space from the bottom up. Underfloor heating can be used to its maximum effect when combined with a heat pump. Together the two technologies produce the most cost-efficient space heating system in northern Europe and can result in savings of up to 80% when compared with fossil fuel-based systems like oil boilers.

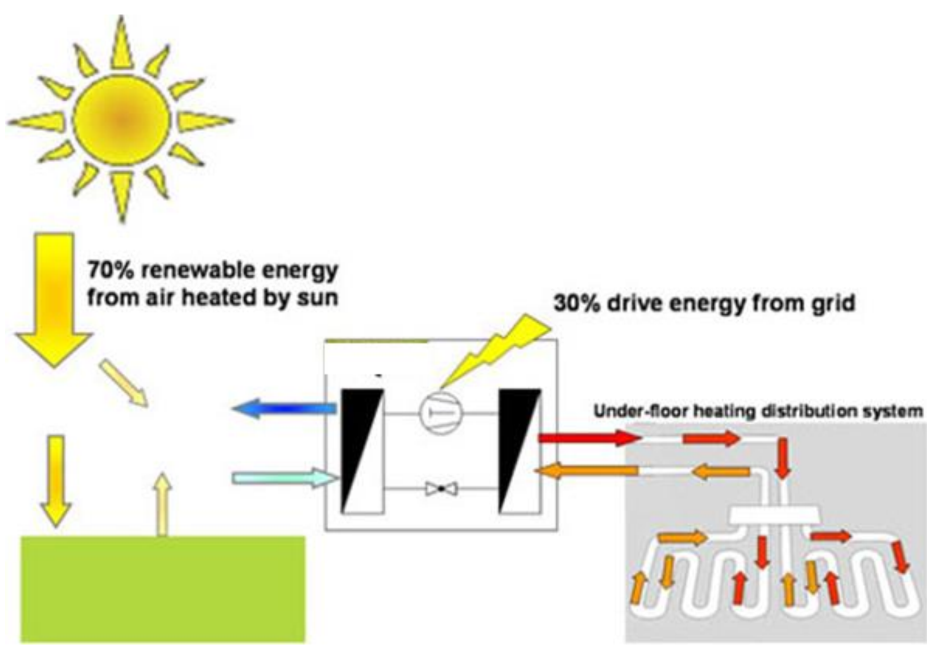


Figure 1 Air to Water heat pump for Eivers Lane Childcare

7.4.1.1 WHAT ARE HEAT PUMPS

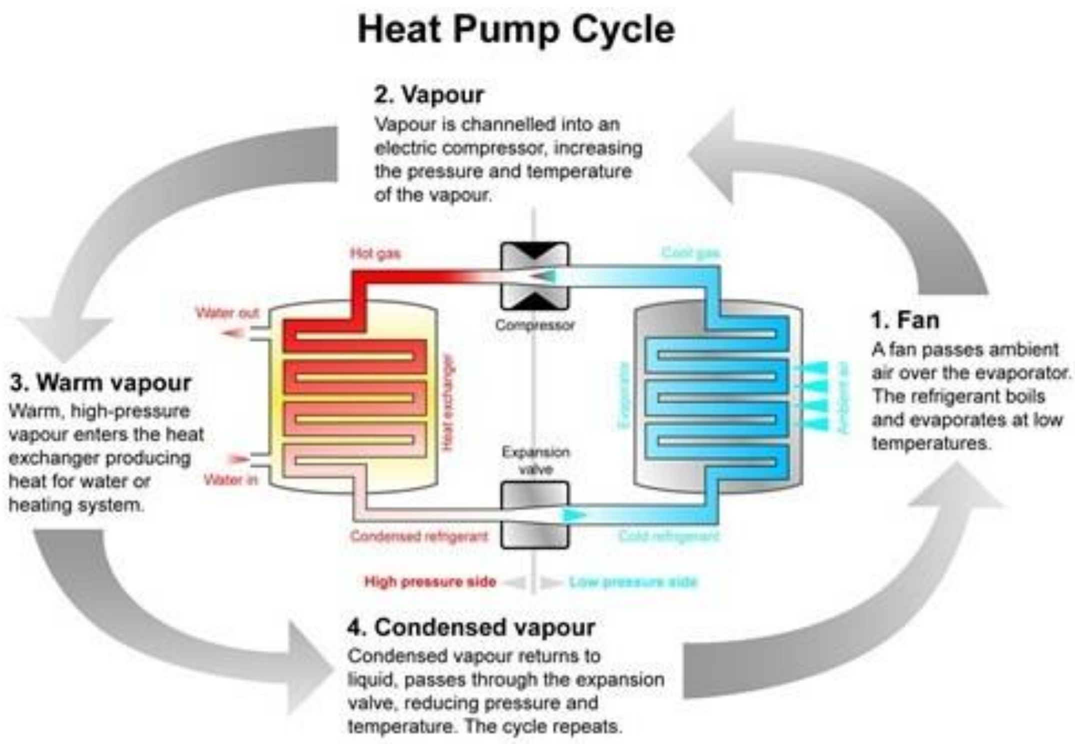
Heat pumps are machines that extract heat from one place, upgrade it to a higher temperature and move it to another place. Heat pumps work by circulating refrigerant liquids between two heat exchanger's with a compressor pump.

The most common everyday items that use heat pump technology are fridges and freezers. Warm air is extracted from inside these appliances and vented outward. Heat pumps are also used for thermal heating. They extract heat from a heat source but instead of releasing it into the air, like fridges and freezers, they put it into water that circulates through radiators or under-floor heating.

The remarkable thing about heat pumps is that they can extract useful heat from low temperature sources, even down to 20 degrees below freezing.

7.4.1.2 AIR TO WATER HEAT PUMP BENEFITS

An air to water heat pump typically costs 50% to 60% less for heating than a tradition fossil fuel system such as an oil or gas boiler. Put simply the 'efficiency' of an air to water heat pump is from 320% to 400% or more whereas even a condensing boiler has an efficiency of only 92%. This essentially means that for every 4 units of heat put into the building, 3 of those units come free from the outside environment. The main benefit of an air to water heat pump is very high efficiency resulting in low heating costs for the building. Because most of the heat energy supplied to the building is free from nature, there is a very low carbon foot print which gives a better energy rating compared to 'traditional' fossil fuel-based heating systems. The main benefit to you is low running costs for your heating.



Air to Water Heat Pump Types

There are essentially two main types of air to water heat pumps, split systems and mono block systems.

A split system air to water heat pump consists of an outside heat exchanger and fan unit and compressor and an indoor unit. The two units are connected by refrigerant pipes. The outdoor unit extracts the heat from the air and passes this heat energy to the refrigerant in the system. The refrigerant is compressed up to a high temperature and is circulated to the indoor unit which has a heat exchanger which takes the high temperature heat from the refrigerant and passes it to the water that circulates to the heating and hot water system.

A mono block air to water heat pump consists of a single outside unit that contains the air to refrigerant heat exchanger, the compressor and the refrigerant to water heat exchanger. In this mono block unit the heat is extracted from the air and passed to the refrigerant, the refrigerant is compressed up to a higher temperature and the heat from the refrigerant is passed to the water that circulates to the heating and hot water system. This outside mono block unit is connected into your house or building by means of two water pipes similar to an outside boiler system.

7.4.2 COSTS AND PAYBACK

The installation of the 36kW Air to Water Heat Pump and the associated works of a 500l buffer tank and a 200l cylinder are all part of the works required. The expected costs are €26,500 incl. VAT for the supply and fit. The heat pump will reduce the spend on both thermal heating and hot water heating in the building.

Item	Annual Savings (€)	Investment (€)	ROI (Years)
36kW AtW Heat Pump plus associated works	3,312	26,500	8

7.4.2.1 TIMEFRAMES

Typically, the timeframe for completing an Air to Water Heat Pump is circa. 3 weeks.

7.4.2.2 PLANNING IMPLEMENTATIONS

Installing a Heat Pump is exempt from planning permission.

8 Reynolds' Topline Retail Shop

Reynolds Topline Providers is a builder's merchants' retailer.

8.1 Introduction to Renewable Energy

Renewable energy systems are those that tap into the Earth's natural cycles to generate heat or electricity. They do not include fossil fuels (although these are derived from plant matter and, therefore, the sun), but do include biomass (such as timber and energy crops).

The following technologies were considered for Reynolds Topline: Bioenergy and Solar PV. Others are only considered if applicable.

8.2 Significant Energy Users

Significant energy users (SEUs) are a key characteristic of energy performance. All types of energy consumed and energy-using plant, equipment, fixtures and fittings within the business were investigated. The different categories of plant and equipment that use energy were identified.

The Significant Energy User categories identified were as follows;

- **Lighting**
- **Space Heating**

The building is heated through an oil-fired boiler.

8.3 Current Energy Use and Costs

The annual energy use and costs for Reynolds Topline are as follows;

Energy Type	kWh / Annum	Cost (ex VAT)
Electricity	25,412	€4,320
Oil (Kerosene)	13,145	€2,300

8.4 Opportunities for Renewable Energy

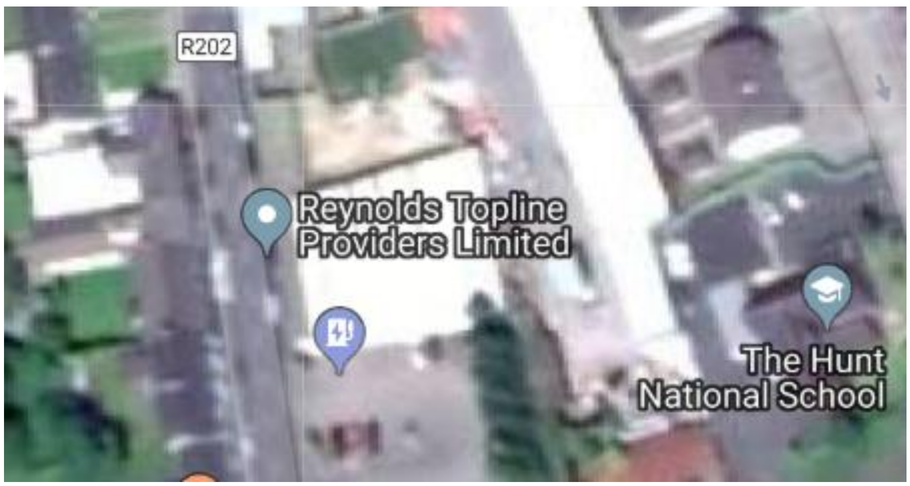
The purpose of this Renewable Energy Feasibility Study was to analyse the effectiveness of technologies related with the production of renewable energy. The goal of this Feasibility Study was to determine which technologies would be more feasible to apply at Reynolds Topline to reduce energy costs and GHG emissions.

The analysis consisted of defining the property, functioning and energy output of each renewable energy technology. From an analysis of the potential renewable energy technologies that would be best suited to building, the following are the Renewable Energy opportunities;

The renewable energy technologies identified were;

- **Solar PV**
- **Bioenergy**

The building has had previous energy efficiency measures completed, eg. Lighting.



8.4.1 SOLAR PV

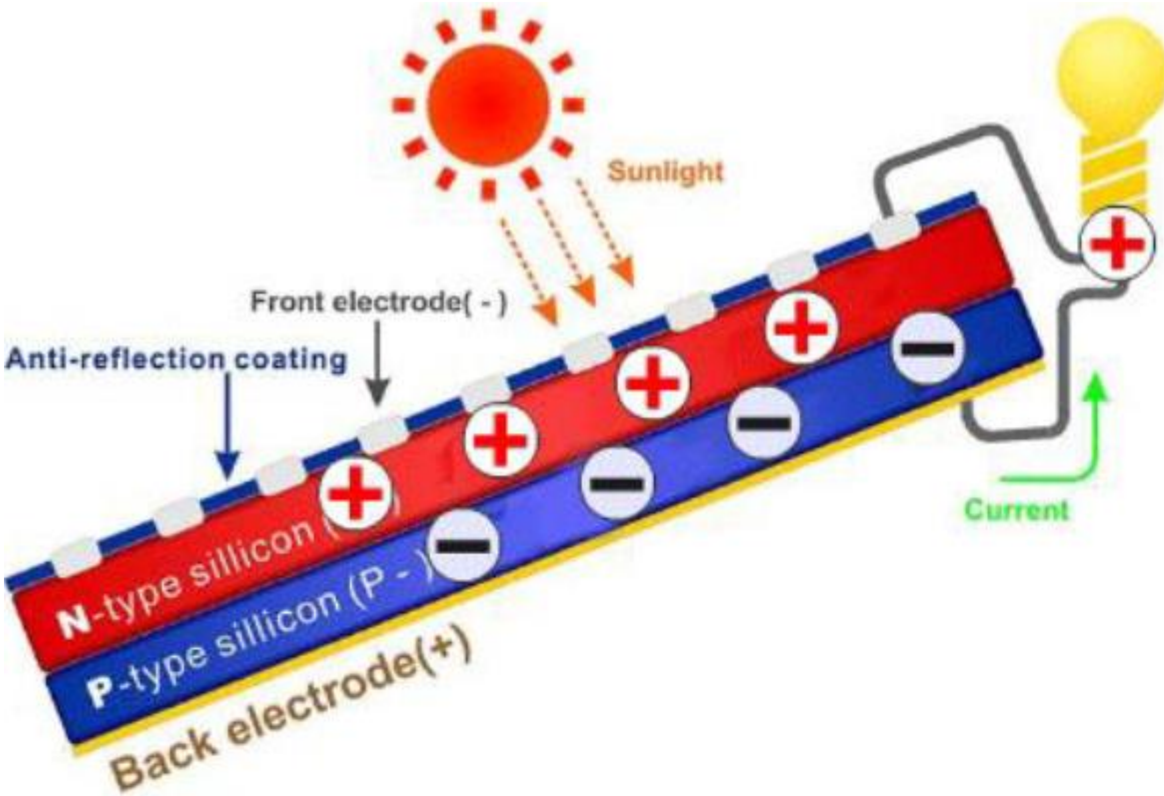
8.4.1.1 BACKGROUND

The sun provides free renewable energy, which makes it one of the most cost-effective solutions compared to traditional resources, such as coal, oil or nuclear power. Furthermore, the sun represents an inexhaustible energy source. Solar energy technologies are characterised by such beneficial features as low running cost, long lifetime, and silent non-polluting energy generation.

Energy from the sun can be harnessed during daylight hours to generate heat or power. Cloud cover does not stop solar energy collection, but at any given moment energy collection is maximised when cloud cover is low, the angle of the sun is high, and the collector is oriented so that it faces the sun. Solar energy is collected and converted using a limited number of broad principles – although there are many variations associated with each.

A photovoltaic or PV module is commonly made from a number of cells connected together in series. In accordance with the spectrum of available light, various materials display varying efficiencies. Therefore, depending on the manufacturing material solar modules are optimised for light absorption prior or beyond the Earth's atmosphere.

Solar panels use light energy from the sun to generate electricity through the photovoltaic effect. Photovoltaic modules or solar panels are made from semiconductor materials, such as silicon. Impurities are added to simulate a doping effect and increase the number of charge carriers within the semiconductor material. When impurities are added, two different layers are created: one of n-type material, which has too many electrons, and one of p-type material, which has too few. Junction between the two layers is known as a p-n junction. This technique is used to manufacture transistors and integrated circuits (silicon chips).



Light consists of packets of energy called photons. Depending on their wavelength, photons are either reflected or absorbed. The energy from the absorbed photons is given to the electrons in the material, which causes some of them to cross the p-n junction. Both cell sides must be connected in order to get a current flow. Current is proportional to the number of absorbed photons and therefore proportional to the light intensity.

8.4.1.2 SOLAR PV OPPORTUNITY

The building is ideally orientated with a south facing roof for a roof mounted solar array. The principle of achieving a net zero energy building using solar energy will require some tariff to sell export power, as it would not be feasible to match the on-site demand on a seasonal basis. Based on the data below the system is sized to optimise on-site use.
The solar panels would be installed on the flat roof and they would be able to be ideally mounted south facing with no shading affecting the solar gain.

The shop is open 6 days per week and is closed on Sundays. Battery storage can be incorporated as this will improve the efficiency as the Sunday energy can be stored and used during the peak hours during weekdays.

8.4.2 COSTS AND PAYBACK

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
11kW Roof Mounted	36	300	59.4	10.80	€10,726	10,706	€1,713	6.3

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
11kW Roof Mounted incl. Storage	36	300	50.00	10.80	€27,500	13,952	€2,232	12.3

All figures are excl. VAT and capital funding support. Figures include supply & fit and all associated works required.

8.4.2.1 TIMEFRAMES

Typically, the timeframe for completing a Solar PV of less 11kW is circa. 4 weeks.

8.4.2.2 PLANNING IMPLEMENTATIONS

For the roof mounted Solar PV opportunity planning permission is exempt. Any commercial solar system with a footprint of less than 50 m^2 is deemed planning exempt in the Republic of Ireland.

8.4.3 BIOMASS – WOOD PELLET FOR SPACE HEATING

As the price of oil and gas continues upwards, it is becoming more and more essential that we look at alternative means of space heating. Wood pellet boilers offer a more economical and energy efficient alternative to oil or gas without compromising on the reliability, convenience or automation of traditional systems.

Alternative fuel for space heating is becoming more and more important as the cost of fossil fuels continue to rise. As oil and gas become scarcer and more difficult to extract from the earth, prices are continuing to rise. Also, carbon tax on fossil fuels is likely to rise and rise as government policies continue to encourage a move from fossils and towards renewable energy. This policy is necessary to meet EU directives for a reduction in carbon emissions. All this means that renewable energy is quickly becoming the norm.

Background to Wood Pellet Boiler

The Grant Condensing Spira Wood Pellet Boiler was the first condensing woodpellet boiler that was EU approved with efficiencies up to 97% gross and is an alternative to oil, gas or solid fuel and can reduce fuel bills by up to 46%.

The highly efficient Grant Spira Condensing Wood Pellet Boilers utilises Grant's award winning patented stainless steel turbulator baffle system, which is featured in Vortex Condensing oil-fired boilers. The units are available in outputs of 6-26kW with an efficiency of 97.4% gross, and 9-36kW with an efficiency of 93.1% gross. They come complete with a 110kg pellet store/hopper, which automatically supplies the Spira with fuel.

It is important to note that in some other modern pellet boilers, up to 20% of the energy that is produced is lost to the atmosphere through waste gases exhausted by the flue system. The Spira has a unique secondary condensing heat exchanger which has been designed to capture most of this lost latent heat energy, so it can maintain extremely high efficiencies. The boiler's cleaning system will periodically wash the condensing unit of any debris in the tubes and also activate the brazier within the burner to clear the combustion head of ash build up, which reduces maintenance time.

8.4.4 COSTS AND PAYBACK

Wood pellet boilers are scientifically tested to ensure they achieve very high efficiency levels of up to 97%. This means very little heat is lost during combustion. In contrast, most traditional oil and gas heating systems only achieve around 80% efficiency and this can be significantly lower (as low as 60%) if a boiler is old or hasn't been serviced regularly.

Note: If the standard oil boiler is eg. 70% efficient, that means that for every €100 spent on oil, only €70 is reaching the building as heat with the remaining €30 gone up the chimney or flue.

Wood pellets cost approx €260 per tonne and heating oil costs approx. €793 per 1,000 litres. 2.1 tonnes wood pellets delivers similar heat output as 1,000 litres oil with a cost of €546 which is 31% cheaper than oil at current prices.

Item	Annual Savings (€)	Investment (€)	ROI (Years)
Wood Pellet Boiler	544	5,900	11

9 Baxter's Centra

Baxter's Centra is part of a convenience retail group, with stores in over 450 locations throughout the country. Centra is part of Musgrave Retail Partners Ireland, the retail franchise division of Musgrave Group.

9.1 Introduction to Renewable Energy

Renewable energy systems are those that tap into the Earth's natural cycles to generate heat or electricity. They do not include fossil fuels (although these are derived from plant matter and, therefore, the sun), but do include biomass (such as timber and energy crops).

The following technologies were considered for Baxter's Centra: Solar PV. Others are only considered if applicable.

9.2 Significant Energy Users

Significant energy users (SEUs) are a key characteristic of energy performance. All types of energy consumed and energy-using plant, equipment, fixtures and fittings within the business were investigated. The different categories of plant and equipment that use energy were identified.

The Significant Energy User categories identified were as follows;

- **Refrigeration**
- **Space Heating**
- **Hot Water**
- **Lighting**

9.3 Current Energy Use and Costs

The annual energy use and costs for the business are as follows;

Energy Type	kWh / Annum	Cost (ex VAT)
Electricity	265,800	€39,600

9.4 Opportunities for Renewable Energy

The purpose of this Renewable Energy Feasibility Study was to analyse the effectiveness of technologies related with the production of renewable energy. The goal of this Feasibility Study was to determine which technologies would be more feasible to apply at Baxter's Centra to reduce energy costs and GHG emissions.

The analysis consisted of defining the property, functioning and energy output of each renewable energy technology. From an analysis of the potential renewable energy technologies that would be best suited to building, the following are the Renewable Energy opportunities;

The renewable energy technologies identified were;

- **Solar PV**

Solar PV is the most suitable technology as all the energy used in the business is electricity. Electricity is used for space heating, lighting, refrigeration and water heating. Hot water is used for washing equipment and floors in the deli and shop areas.

9.4.1 SOLAR PV

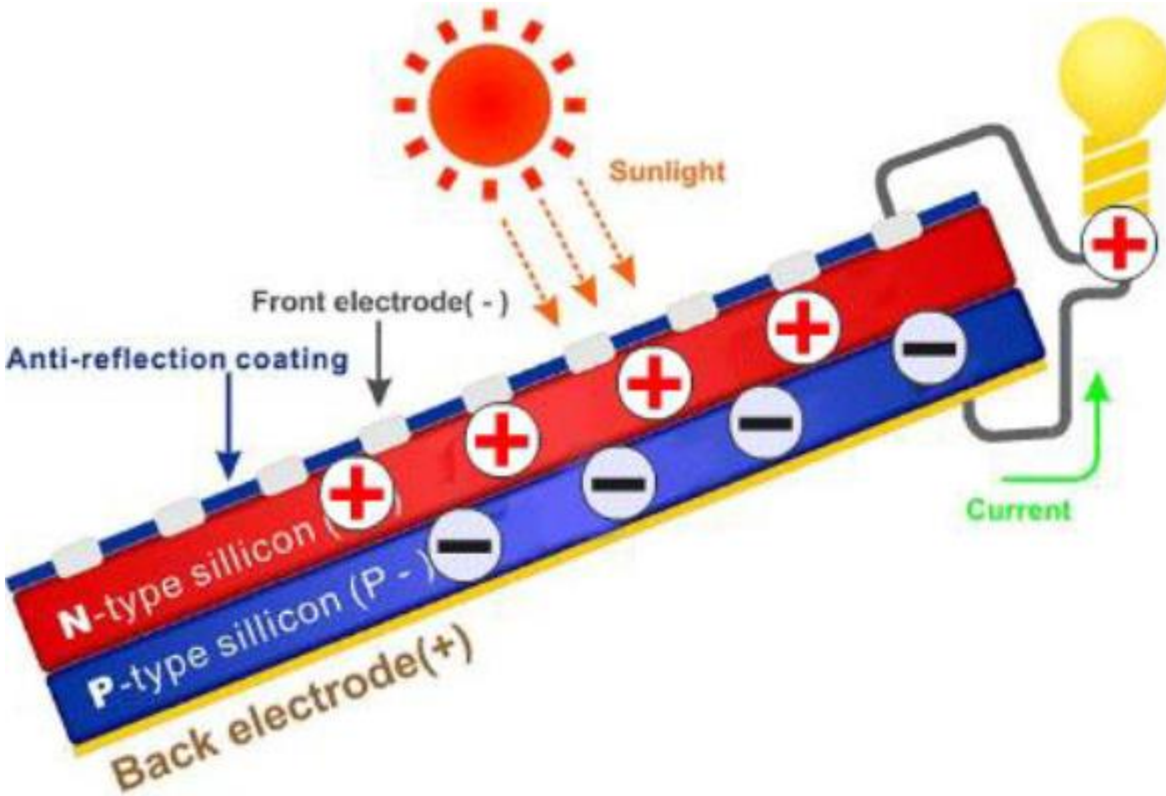
9.4.1.1 BACKGROUND

The sun provides free renewable energy, which makes it one of the most cost-effective solutions compared to traditional resources, such as coal, oil or nuclear power. Furthermore, the sun represents an inexhaustible energy source. Solar energy technologies are characterised by such beneficial features as low running cost, long lifetime, and silent non-polluting energy generation.

Energy from the sun can be harnessed during daylight hours to generate heat or power. Cloud cover does not stop solar energy collection, but at any given moment energy collection is maximised when cloud cover is low, the angle of the sun is high, and the collector is oriented so that it faces the sun. Solar energy is collected and converted using a limited number of broad principles – although there are many variations associated with each.

A photovoltaic or PV module is commonly made from a number of cells connected together in series. In accordance with the spectrum of available light, various materials display varying efficiencies. Therefore, depending on the manufacturing material solar modules are optimised for light absorption prior or beyond the Earth's atmosphere.

Solar panels use light energy from the sun to generate electricity through the photovoltaic effect. Photovoltaic modules or solar panels are made from semiconductor materials, such as silicon. Impurities are added to simulate a doping effect and increase the number of charge carriers within the semiconductor material. When impurities are added, two different layers are created: one of n-type material, which has too many electrons, and one of p-type material, which has too few. Junction between the two layers is known as a p-n junction. This technique is used to manufacture transistors and integrated circuits (silicon chips).



Light consists of packets of energy called photons. Depending on their wavelength, photons are either reflected or absorbed. The energy from the absorbed photons is given to the electrons in the material, which causes some of them to cross the p-n junction. Both cell sides must be connected in order to get a current flow. Current is proportional to the number of absorbed photons and therefore proportional to the light intensity.

9.4.1.2 SOLAR PV OPPORTUNITY

The building is ideally orientated with a south facing roof for a roof mounted solar array. The principle of achieving a net zero energy building using solar energy will require some tariff to sell export power, as it would not be feasible to match the on-site demand on a seasonal basis. Based on the data below the system is sized to optimise on-site use.

The shop is open 7 days per week from 8am to 10pm.

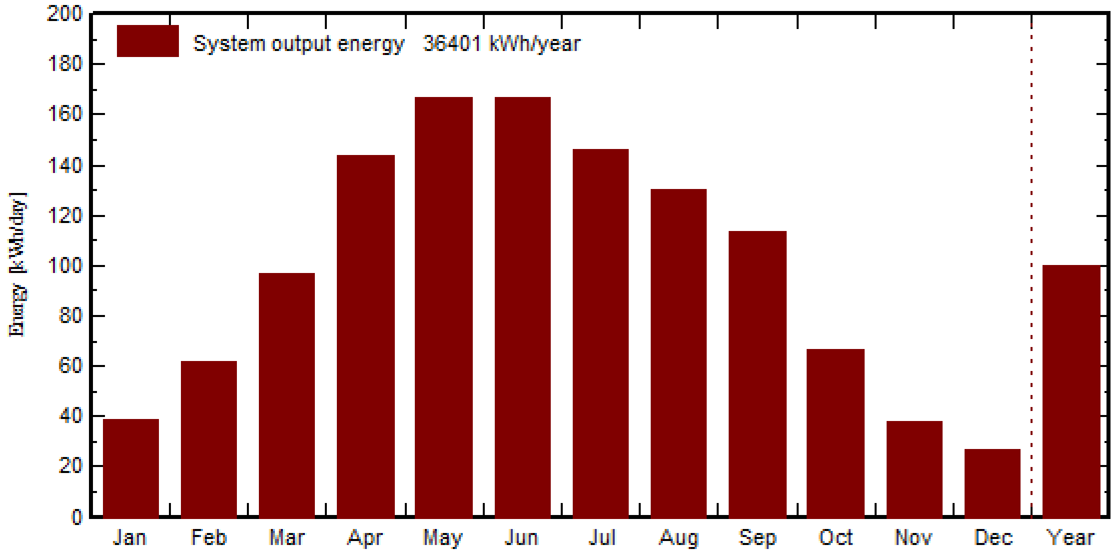
9.4.2 COSTS AND PAYBACK

The pitched roof of Baxter's Centra is approximately 292m^2, however only a small portion of the roof is south facing which limits the size of the Solar PV project.

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
11kW Roof Mounted	36	300	50.00	10.80	€10,626	8,711	€1,306	8.1

If the solar system was to be installed on the flat roof to the rear of the building this would allow for a greater size of Solar PV System however there will be some shading from the existing pitched roof at the front of the building. The calculations are as follows for the flat roof system;

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
Flat Roof mounted Solar PV	140	295	231	41.30	€40,633	31,930	€4,789	8.4



	Gl. horiz. kWh/m².day	Coll. Plane kWh/m².day	System output kWh/day	System output kWh
Jan.	0.61	1.24	38.53	1194
Feb.	1.22	1.97	61.32	1717
Mar.	2.26	3.11	96.98	3006
Apr.	3.83	4.60	143.3	4300
May	4.98	5.36	167.1	5179
June	5.20	5.34	166.7	5000
July	4.47	4.69	146.2	4532
Aug.	3.76	4.17	130.0	4030
Sep.	2.79	3.65	113.8	3413
Oct.	1.42	2.14	66.82	2072
Nov.	0.67	1.21	37.65	1130
Dec.	0.41	0.86	26.72	828
Year	2.64	3.20	99.73	36401

All figures are excl. VAT and capital funding support. Figures include supply & fit and all associated works required.

9.4.2.1 TIMEFRAMES

Typically, the timeframe for completing a Solar PV of less 11kW is circa. 4 weeks.

9.4.2.2 PLANNING IMPLEMENTATIONS

For the roof mounted Solar PV opportunity planning permission is exempt. Any commercial solar system with a footprint of less than 50 m^2 is deemed planning exempt in the Republic of Ireland.

10 Modular Systems

Modular Panel Systems are manufacturers and suppliers of insulated wall, roof and door system solutions in Ireland.

10.1 Introduction to Renewable Energy

Renewable energy systems are those that tap into the Earth's natural cycles to generate heat or electricity. They do not include fossil fuels (although these are derived from plant matter and, therefore, the sun), but do include biomass (such as timber and energy crops).

The following technologies were considered for Modular Systems: Biomass and Solar PV. Others are only considered if applicable.

10.2 Significant Energy Users

Significant energy users (SEUs) are a key characteristic of energy performance. All types of energy consumed and energy-using plant, equipment, fixtures and fittings within the business were investigated. The different categories of plant and equipment that use energy were identified.

The Significant Energy User categories identified were as follows;

- **Space heating**
- **Compressed air**
- **Motors and pumps**
- **Lighting**
- **IT**

10.3 Current Energy Use and Costs

The annual energy use and costs for the business are as follows;

Fuel	2018	
	Consumption (kWh)	Spend (€ Excl. VAT)
Electricity	81,085	11,352
Kerosene	86,725	6,912
Total	167,810	18,264

10.4 Opportunities for Renewable Energy

The purpose of this Renewable Energy Feasibility Study was to analyse the effectiveness of technologies related with the production of renewable energy. The goal of this Feasibility Study was to determine which technologies would be more feasible to apply at the business to reduce energy costs and GHG emissions.

The analysis consisted of defining the property, functioning and energy output of each renewable energy technology. From an analysis of the potential renewable energy technologies that would be best suited to building, the following are the Renewable Energy opportunities;

The renewable energy technologies identified were;

- **Biomass**
- **Solar PV**

10.4.1 SOLAR PV

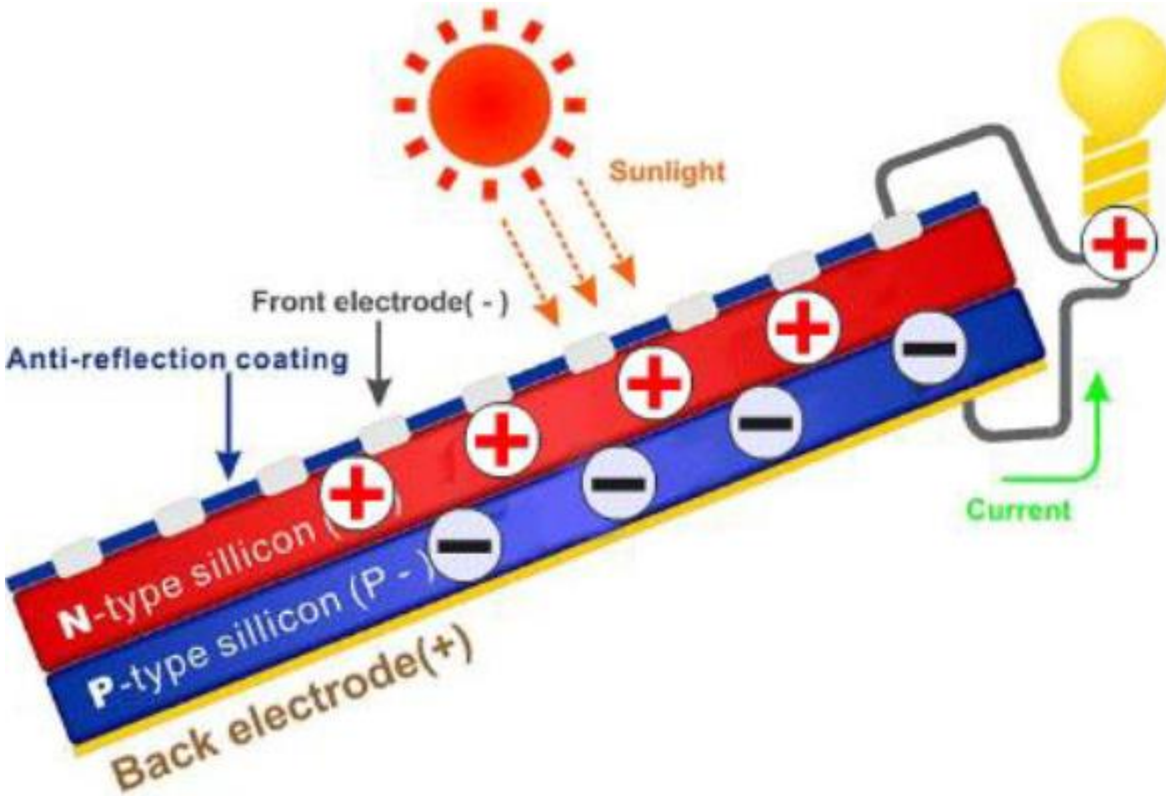
10.4.1.1 BACKGROUND

The sun provides free renewable energy, which makes it one of the most cost-effective solutions compared to traditional resources, such as coal, oil or nuclear power. Furthermore, the sun represents an inexhaustible energy source. Solar energy technologies are characterised by such beneficial features as low running cost, long lifetime, and silent non-polluting energy generation.

Energy from the sun can be harnessed during daylight hours to generate heat or power. Cloud cover does not stop solar energy collection, but at any given moment energy collection is maximised when cloud cover is low, the angle of the sun is high, and the collector is oriented so that it faces the sun. Solar energy is collected and converted using a limited number of broad principles – although there are many variations associated with each.

A photovoltaic or PV module is commonly made from a number of cells connected together in series. In accordance with the spectrum of available light, various materials display varying efficiencies. Therefore, depending on the manufacturing material solar modules are optimised for light absorption prior or beyond the Earth's atmosphere.

Solar panels use light energy from the sun to generate electricity through the photovoltaic effect. Photovoltaic modules or solar panels are made from semiconductor materials, such as silicon. Impurities are added to simulate a doping effect and increase the number of charge carriers within the semiconductor material. When impurities are added, two different layers are created: one of n-type material, which has too many electrons, and one of p-type material, which has too few. Junction between the two layers is known as a p-n junction. This technique is used to manufacture transistors and integrated circuits (silicon chips).



Light consists of packets of energy called photons. Depending on their wavelength, photons are either reflected or absorbed. The energy from the absorbed photons is given to the electrons in the material, which causes some of them to cross the p-n junction. Both cell sides must be connected in order to get a current flow. Current is proportional to the number of absorbed photons and therefore proportional to the light intensity.

10.4.1.2 SOLAR PV OPPORTUNITY

The building has a south-west facing roof for a roof mounted solar array. The principle of achieving a net zero energy building using solar energy will require some tariff to sell export power, as it would not be feasible to match the on-site demand on a seasonal basis. Based on the data below the system is sized to optimise on-site use.

The business is operating Monday to Friday with limited use during the weekend.

10.4.2 COSTS AND PAYBACK

The roof of Modular Panel Systems is approximately 1,437m^2. The front part of the roof which would be suitable for Solar PV is 796 m^2.

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
53kW Roof mounted Solar PV	180	295	297	53.10	€52,243	42,099	€7,269	7.1

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
53kW Roof Mounted incl. Storage	180	295	297	53.10	€110,607	58,385	€9,342	11.8

All figures are excl. VAT and capital funding support. Figures include supply & fit and all associated works required.

10.4.2.1 TIMEFRAMES

Typically, the timeframe for completing Solar PV of 53kW is increased due to planning and also the larger scale of the project. Generally, a valid application will be dealt with by a planning authority in 12 weeks from the date the application is made to the final grant of a permission. However, the period can vary, particularly if the planning authority seeks further information from the applicant (which it should do within the first 8 weeks).

Therefore, the full project would be expected be circa. 30 weeks.

10.4.3 BIOMASS – WOOD PELLET FOR SPACE HEATING

As the price of oil and gas continues upwards, it is becoming more and more essential that we look at alternative means of space heating. Wood pellet boilers offer a more economical and energy efficient alternative to oil or gas without compromising on the reliability, convenience or automation of traditional systems.

Alternative fuel for space heating is becoming more and more important as the cost of fossil fuels continue to rise. As oil and gas become scarcer and more difficult to extract from the earth, prices are continuing to rise. Also, carbon tax on fossil fuels is likely to rise and rise as government policies continue to encourage a move from fossils and towards renewable energy. This policy is necessary to meet EU directives for a reduction in carbon emissions. All this means that renewable energy is quickly becoming the norm.

Background to Wood Pellet Boilers

The Grant Condensing Spira Wood Pellet Boiler was the first condensing woodpellet boiler that was EU approved with efficiencies up to 97% gross and is an alternative to oil, gas or solid fuel and can reduce fuel bills by up to 46%.

The highly efficient Grant Spira Condensing Wood Pellet Boilers utilises Grant's award winning patented stainless steel turbulator baffle system, which is featured in Vortex Condensing oil-fired boilers. The units are available in outputs of 6-26kW with an efficiency of 97.4% gross, and 9-36kW with an efficiency of 93.1% gross. They come complete with a 110kg pellet store/hopper, which automatically supplies the Spira with fuel.

It is important to note that in some other modern pellet boilers, up to 20% of the energy that is produced is lost to the atmosphere through waste gases exhausted by the flue system. The Spira has a unique secondary condensing heat exchanger which has been designed to capture most of this lost latent heat energy, so it can maintain extremely high efficiencies. The boiler's cleaning system will periodically wash the condensing unit of any debris in the tubes and also activate the brazier within the burner to clear the combustion head of ash build up, which reduces maintenance time.

10.4.4 COSTS AND PAYBACK

Wood pellet boilers are scientifically tested to ensure they achieve very high efficiency levels of up to 97%. This means very little heat is lost during combustion. In contrast, most traditional oil and gas heating systems only achieve around 80% efficiency and this can be significantly lower (as low as 60%) if a boiler is old or hasn't been serviced regularly.

Note: If the standard oil boiler is eg. 70% efficient, that means that for every €100 spent on oil, only €70 is reaching the building as heat with the remaining €30 gone up the chimney or flue.

Wood pellets cost approx €260 per tonne and heating oil costs approx. €793 per 1,000 litres. 2.1 tonnes wood pellets delivers similar heat output as 1,000 litres oil with a cost of €546 which is 31% cheaper than oil at current prices.

The annual kerosene consumption, for the building, amounts to approx. 86,725 kWh with €6,912 as the spend.

Item	Annual Savings (€)	Investment (€)	ROI (Years)
Wood Pellet Boiler	1,636	5,800	3.5

11 Old VEC School

11.1 Introduction to Renewable Energy

Renewable energy systems are those that tap into the Earth's natural cycles to generate heat or electricity. They do not include fossil fuels (although these are derived from plant matter and, therefore, the sun), but do include biomass (such as timber and energy crops).

11.2 Significant Energy Users

Significant energy users (SEUs) are a key characteristic of energy performance. All types of energy consumed and energy-using plant, equipment, fixtures and fittings within the business were investigated. The different categories of plant and equipment that use energy were identified.

The Significant Energy User categories identified were as follows;

- **Space heating**
- **Lighting**

11.3 Current Energy Use and Costs

The approx. annual energy use and costs for the school are as follows;

Fuel	2018	
	Consumption (kWh)	Spend (€ Excl. VAT)
Electricity	87,988	14,335
Oil	206,101	16,426
Total	294,089	30,761

11.4 Opportunities for Renewable Energy

The purpose of this Renewable Energy Feasibility Study was to analyse the effectiveness of technologies related with the production of renewable energy. The goal of this Feasibility Study was to determine which technologies would be more feasible to apply at the business to reduce energy costs and GHG emissions.

The analysis consisted of defining the property, functioning and energy output of each renewable energy technology. From an analysis of the potential renewable energy technologies that would be best suited to building, the following are the Renewable Energy opportunities;

The renewable energy technologies identified were;

- **Heat Pump**
- **Solar PV**

Others are only considered if applicable.

11.4.1 SOLAR PV

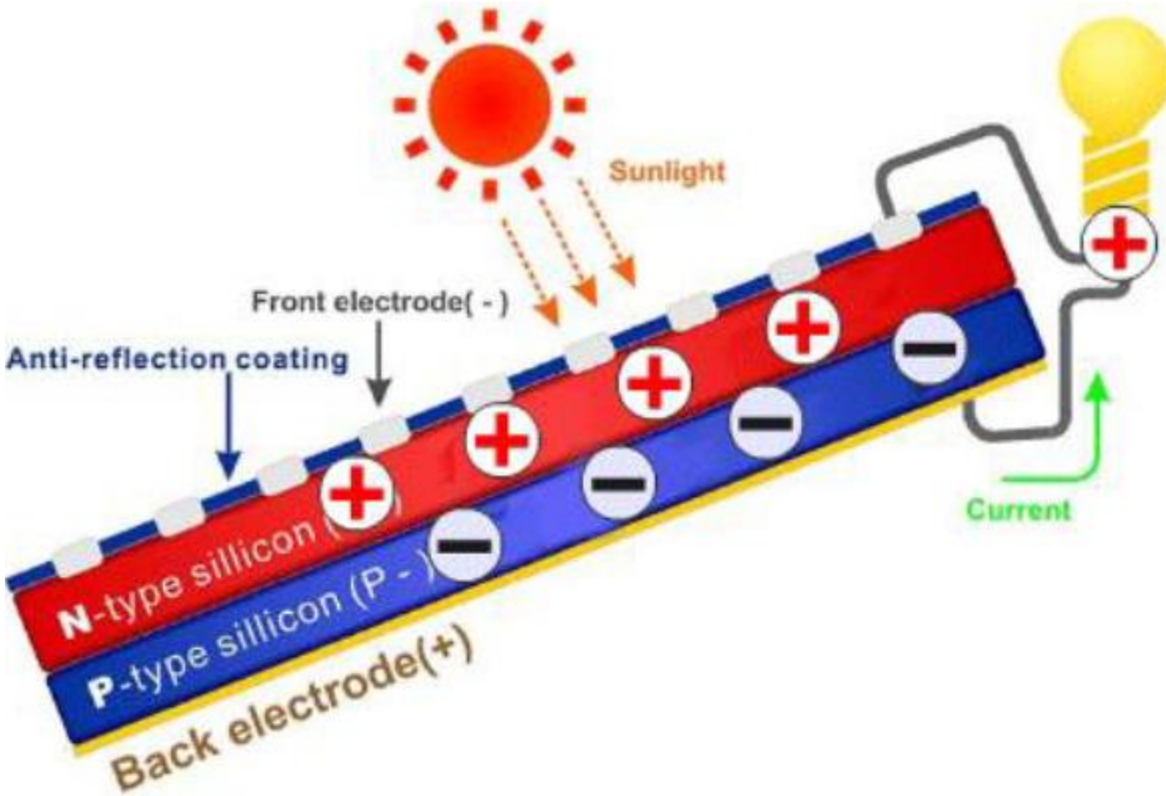
11.4.1.1 BACKGROUND

The sun provides free renewable energy, which makes it one of the most cost-effective solutions compared to traditional resources, such as coal, oil or nuclear power. Furthermore, the sun represents an inexhaustible energy source. Solar energy technologies are characterised by such beneficial features as low running cost, long lifetime, and silent non-polluting energy generation.

Energy from the sun can be harnessed during daylight hours to generate heat or power. Cloud cover does not stop solar energy collection, but at any given moment energy collection is maximised when cloud cover is low, the angle of the sun is high, and the collector is oriented so that it faces the sun. Solar energy is collected and converted using a limited number of broad principles – although there are many variations associated with each.

A photovoltaic or PV module is commonly made from a number of cells connected together in series. In accordance with the spectrum of available light, various materials display varying efficiencies. Therefore, depending on the manufacturing material solar modules are optimised for light absorption prior or beyond the Earth's atmosphere.

Solar panels use light energy from the sun to generate electricity through the photovoltaic effect. Photovoltaic modules or solar panels are made from semiconductor materials, such as silicon. Impurities are added to simulate a doping effect and increase the number of charge carriers within the semiconductor material. When impurities are added, two different layers are created: one of n-type material, which has too many electrons, and one of p-type material, which has too few. Junction between the two layers is known as a p-n junction. This technique is used to manufacture transistors and integrated circuits (silicon chips).



Light consists of packets of energy called photons. Depending on their wavelength, photons are either reflected or absorbed. The energy from the absorbed photons is given to the electrons in the material, which causes some of them to cross the p-n junction. Both cell sides must be connected in order to get a current flow. Current is proportional to the number of absorbed photons and therefore proportional to the light intensity.

11.4.1.2 SOLAR PV OPPORTUNITY

The building is ideally orientated with a south facing roof for a roof mounted solar array. The principle of achieving a net zero energy building using solar energy will require some tariff to sell export power, as it would not be feasible to match the on-site demand on a seasonal basis. Based on the data below the system is sized to optimise on-site use.

11.4.2 COSTS AND PAYBACK

The pitched roof of Old VEC School is approximately 1,040m^2, however only 220m^2 of the roof is south-west facing which limits the size of the Solar PV project.

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
35kW Roof mounted Solar PV	120	295	198	35.40	€34,829	27,350	€4,102	8.4

All figures are excl. VAT and capital funding support. Figures include supply & fit and all associated works required. The figures are based on the building to be used full time during the day and all months of the year as the building is currently being considered for renovation and to then be used as a community building as opposed to a school.

11.4.2.1 TIMEFRAMES AND PLANNING PERMISSION

Typically, the timeframe for completing Solar PV of 35kW is increased due to planning and also the larger scale of the project. Generally, a valid application will be dealt with by a planning authority in 12 weeks from the date the application is made to the final grant of a permission. However, the period can vary, particularly if the planning authority seeks further information from the applicant (which it should do within the first 8 weeks).

Therefore, the full project would be expected be circa. 30 weeks.

11.4.3 AIR TO WATER HEAT PUMP

The most efficient and reliable solution for heating the old VEC School building would be an air to water heat pump. Air-to-water heat pumps, due to their ease and low cost of installation, are both economically viable and environmentally friendly as a renewable alternative to traditional heat generators. With oil prices expected to increase continuously the heat pump will save further in this respect and with the reduced maintenance costs compared to the oil boiler this will shorten the payback period also.
Currently there are radiators with an old oil boiler for heating the building.

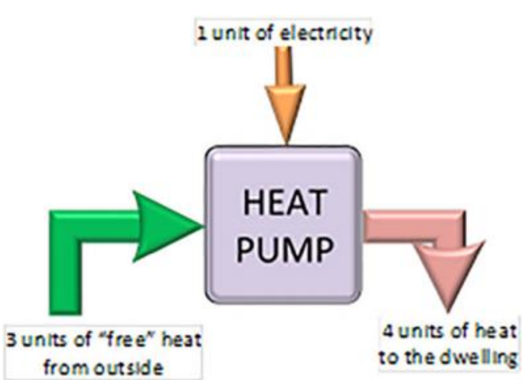
11.4.3.1 WHAT ARE HEAT PUMPS

Heat pumps are machines that extract heat from one place, upgrade it to a higher temperature and move it to another place. Heat pumps work by circulating refrigerant liquids between two heat exchangers with a compressor pump.

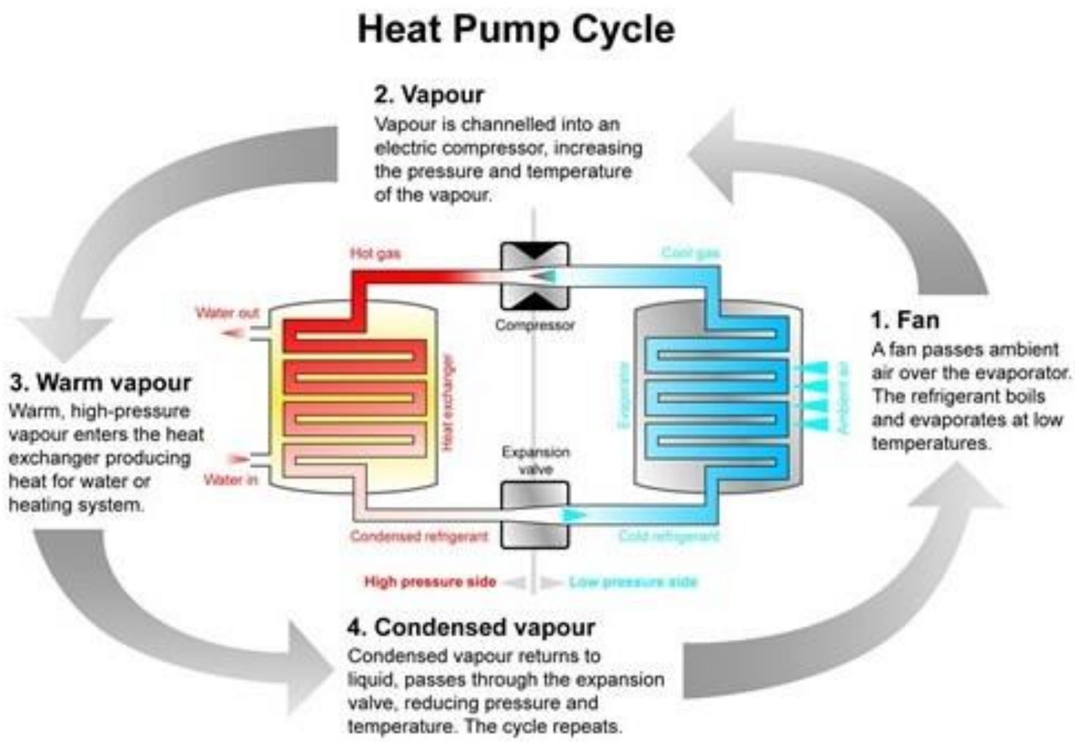
The most common everyday items that use heat pump technology are fridges and freezers. Warm air is extracted from inside these appliances and vented outward. Heat pumps are also used for thermal heating. They extract heat from a heat source but instead of releasing it into the air, like fridges and freezers, they put it into water that circulates through radiators or under-floor heating.

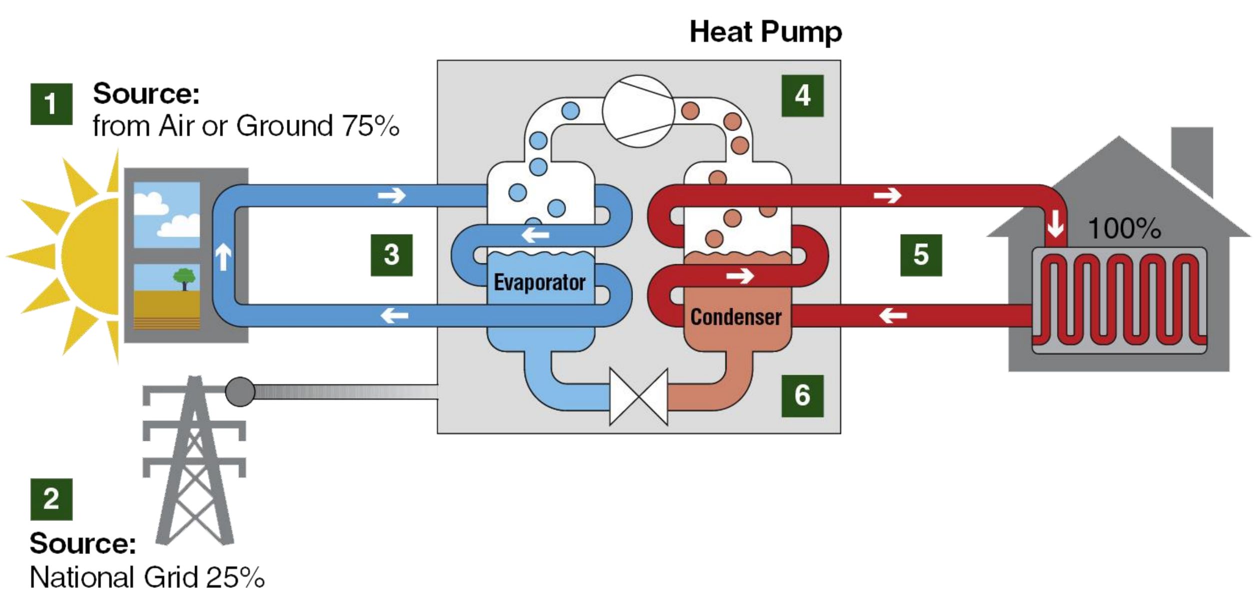
The remarkable thing about heat pumps is that they can extract useful heat from low temperature sources, even down to 20 degrees below freezing.

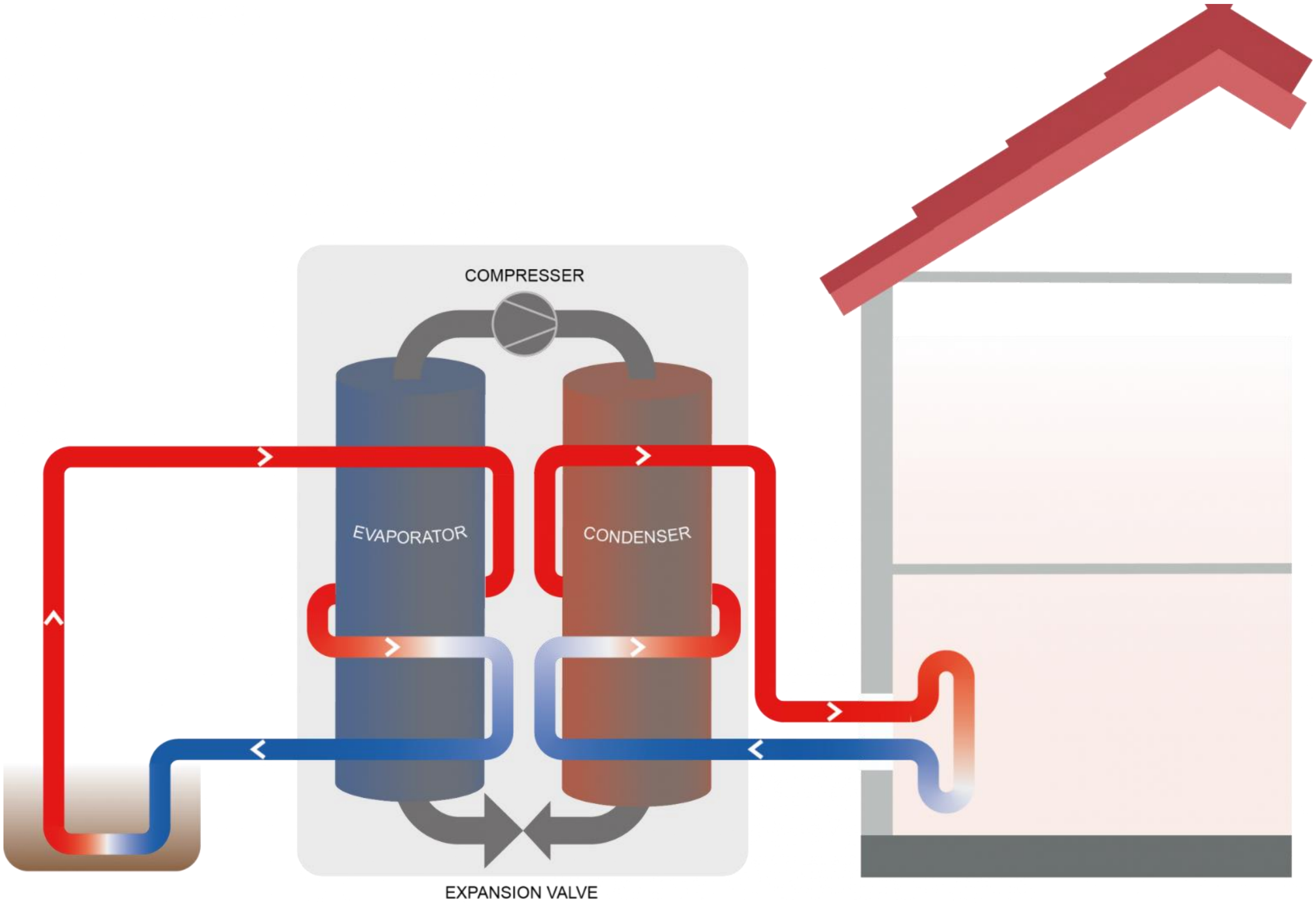
11.4.3.2 AIR TO WATER HEAT PUMP BENEFITS



An air to water heat pump typically costs 50% to 60% less for heating than a tradition fossil fuel system such as an oil or gas boiler. Put simply the 'efficiency' of an air to water heat pump is from 320% to 400% or more whereas even a condensing boiler has an efficiency of only 92%. This essentially means that for every 4 units of heat put into the building, 3 of those units come free from the outside environment. The main benefit of an air to water heat pump is very high efficiency resulting in low heating costs for the building. Because most of the heat energy supplied to the building is free from nature, there is a very low carbon foot print which gives a better energy rating compared to ‘traditional’ fossil fuel-based heating systems. The main benefit to you is low running costs for your heating.







Air to Water Heat Pump Types
There are essentially two main types of air to water heat pumps, split systems and mono block systems.

A split system air to water heat pump consists of an outside heat exchanger and fan unit and compressor and an indoor unit. The two units are connected by refrigerant pipes. The outdoor unit extracts the heat from the air and passes this heat energy to the refrigerant in the system. The refrigerant is compressed up to a high temperature and is circulated to the indoor unit which has a heat exchanger which takes the high temperature heat from the refrigerant and passes it to the water that circulates to the heating and hot water system.

A mono block air to water heat pump consists of a single outside unit that contains the air to refrigerant heat exchanger, the compressor and the refrigerant to water heat exchanger. In this mono block unit the heat is extracted from the air and passed to the refrigerant, the refrigerant is compressed up to a higher temperature and the heat from the refrigerant is passed to the water that circulates to the heating and hot water system. This outside mono block unit is connected into your house or building by means of two water pipes similar to an outside boiler system.

11.4.4 COSTS AND PAYBACK

The installation of the 36kW Air to Water Heat Pump and the associated works required. The expected costs are €26,500 incl. VAT for the supply and fit.

Item	Annual Savings (€)	Investment (€)	ROI (Years)
36kW Heat Pump	4,693	26,500	5.6

*For a Heat Pump to work in this building it is recommended to upgrade both the ceiling and wall insulation to the standards below, otherwise the heat pump will not efficiently and wouldn't provide the ROI in the table above.

11.4.5 CEILING INSULATION

There is a pitched roof in Mohill Secondary School. There is a suspended ceiling in the building. There is circa 50mm ceiling insulation.
It is recommended to upgrade the roofs to 300mm of mineral wool insulation to bring it up to current standards, resulting in a u-value of 0.13 W/m2K. The pitched roof should be ventilated to current standards also.

Element	Upgrade	Nett Area (m2)	Thermal Saving (kWh)	Electrical Saving (kWh)	Saving (€)	Capital Cost (€)	Payback Period (Years)
Roofs:							
Pitched Roof	Ceiling Level Insulation	1040	11,123	0	1,780	21,892	12.3

11.4.6 WALL INSULATION

The external walls consist of wall construction, with circa 50mm of EPS insulation in the 100mm cavity. The u-value of the walls is circa 0.6 W/m2K. It is recommended to install cavity wall insulation into the remainder of the cavities, improving the u-value of the wall to circa 0.3 W/m2K.

Element	Upgrade	Nett Area (m2)	Thermal Saving (kWh)	Electrical Saving (kWh)	Saving (€)	Capital Cost (€)	Payback Period (Years)
External Walls:							
Cavity Fill - Partially Filled	Cavity Insulation	900	27,945	0	1,677	10,800	6.4

11.4.7 WINDOWS AND DOORS

The windows and doors are in very good condition. There are double glazed windows and entrance doors which were installed circa 1 year ago.

12 Community School

12.1 Introduction to Renewable Energy

Renewable energy systems are those that tap into the Earth's natural cycles to generate heat or electricity. They do not include fossil fuels (although these are derived from plant matter and, therefore, the sun), but do include biomass (such as timber and energy crops).

12.2 Significant Energy Users

Significant energy users (SEUs) are a key characteristic of energy performance. All types of energy consumed and energy-using plant, equipment, fixtures and fittings within the school were investigated. The different categories of plant and equipment that use energy were identified.

The Significant Energy User categories identified were as follows;

- **Space heating**
- **Water heating**
- **Lighting**
- **IT**

12.3 Current Energy Use and Costs

The approx. annual energy use and costs for the school are as follows;

Fuel	2018	
	Consumption (kWh)	Spend (€ Excl. VAT)
Electricity	103,827	16,916
Oil	243,199	19,383
Total	347,026	36,299

12.4 Opportunities for Renewable Energy

The purpose of this Renewable Energy Feasibility Study was to analyse the effectiveness of technologies related with the production of renewable energy. The goal of this Feasibility Study was to determine which technologies would be more feasible to apply at the business to reduce energy costs and GHG emissions.

The analysis consisted of defining the property, functioning and energy output of each renewable energy technology. From an analysis of the potential renewable energy technologies that would be best suited to building, the following are the Renewable Energy opportunities;

The renewable energy technologies identified were;

- **Heat Pump**
- **Solar PV**

Others are only considered if applicable.

12.4.1 SOLAR PV

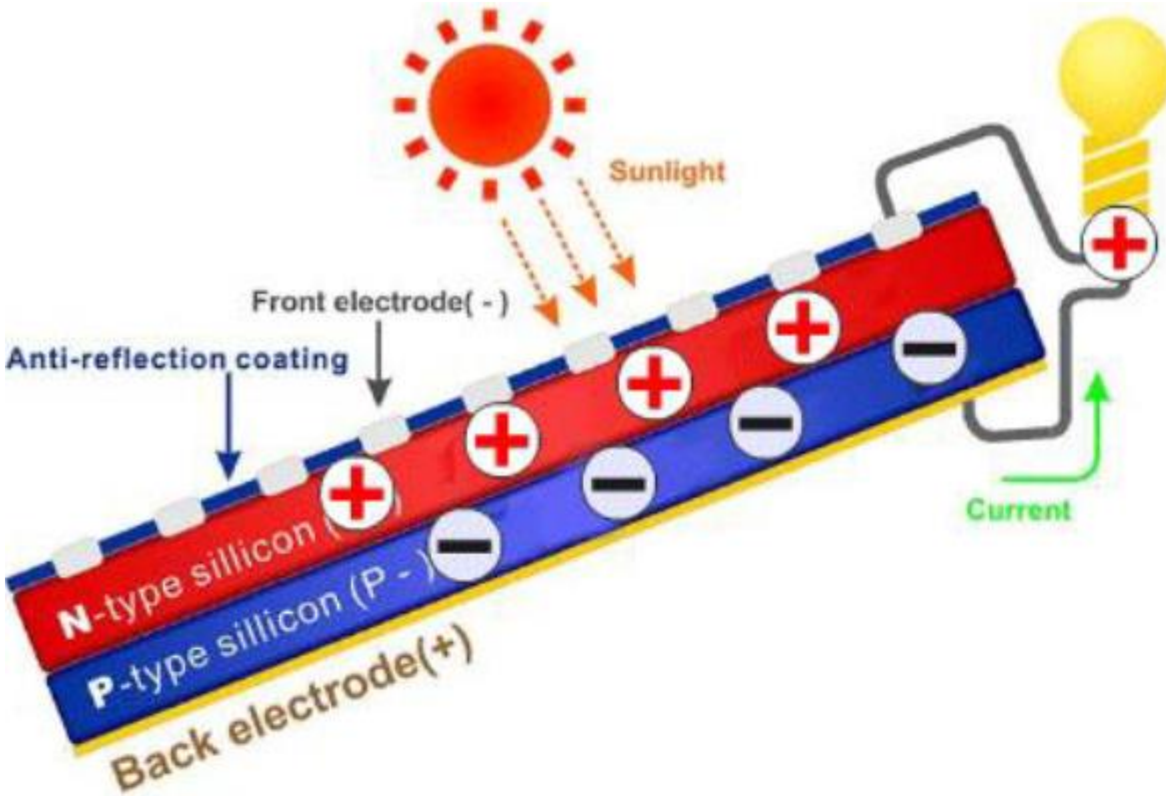
12.4.1.1 BACKGROUND

The sun provides free renewable energy, which makes it one of the most cost-effective solutions compared to traditional resources, such as coal, oil or nuclear power. Furthermore, the sun represents an inexhaustible energy source. Solar energy technologies are characterised by such beneficial features as low running cost, long lifetime, and silent non-polluting energy generation.

Energy from the sun can be harnessed during daylight hours to generate heat or power. Cloud cover does not stop solar energy collection, but at any given moment energy collection is maximised when cloud cover is low, the angle of the sun is high, and the collector is oriented so that it faces the sun. Solar energy is collected and converted using a limited number of broad principles – although there are many variations associated with each.

A photovoltaic or PV module is commonly made from a number of cells connected together in series. In accordance with the spectrum of available light, various materials display varying efficiencies. Therefore, depending on the manufacturing material solar modules are optimised for light absorption prior or beyond the Earth's atmosphere.

Solar panels use light energy from the sun to generate electricity through the photovoltaic effect. Photovoltaic modules or solar panels are made from semiconductor materials, such as silicon. Impurities are added to simulate a doping effect and increase the number of charge carriers within the semiconductor material. When impurities are added, two different layers are created: one of n-type material, which has too many electrons, and one of p-type material, which has too few. Junction between the two layers is known as a p-n junction. This technique is used to manufacture transistors and integrated circuits (silicon chips).



Light consists of packets of energy called photons. Depending on their wavelength, photons are either reflected or absorbed. The energy from the absorbed photons is given to the electrons in the material, which causes some of them to cross the p-n junction. Both cell sides must be connected in order to get a current flow. Current is proportional to the number of absorbed photons and therefore proportional to the light intensity.

12.4.1.2 SOLAR PV OPPORTUNITY

The building is ideally orientated with a south facing roof for a roof mounted solar array. The principle of achieving a net zero energy building using solar energy will require some tariff to sell export power, as it would not be feasible to match the on-site demand on a seasonal basis. Based on the data below the system is sized to optimise on-site use.

12.4.2 COSTS AND PAYBACK

The portion of the Community School roof which is south facing and has a potential for Solar PV is approximately 950m^2. The community school is closed during the summer months and also two weeks at Easter which will affect the size and payback of the Solar PV System which is taken into account below. Electricity generation will be at peak during the summer months however the school will be unable to use this electricity.

	Gl. Horiz.	Coll. Plane	System Output	System Output
	kWh/m2/day	kWh/m2/day	kWh/day	kWh
Jan	0.61	1.24	92.87	2879
Feb	1.22	1.97	147.8	4138
Mar	2.26	3.11	233.7	7246
Apr	1.91	2.3	172.7	5,181
May	4.98	5.36	402.7	12482
Jun				
Jul				
Aug				
Sep	2.79	3.65	274.2	8226
Oct	1.42	2.14	161.1	4993
Nov	0.67	1.21	90.74	2722
Dec	0.41	0.86	64.39	1996
Year	16.27	21.84	1640.2	49863

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
Roof mounted Solar PV	300	295	495	88.50	€87,072	49863	€7,977	11

All figures are excl. VAT and capital funding support. Figures include supply & fit and all associated works required.

12.4.2.1 TIMEFRAMES AND PLANNING PERMISSION

Typically, the timeframe for completing Solar PV of 88kW is increased due to planning and also the larger scale of the project. Generally, a valid application will be dealt with by a planning authority in 12 weeks from the date the application is made to the final grant of a permission. However, the period can vary, particularly if the planning authority seeks further information from the applicant (which it should do within the first 8 weeks).

Therefore, the full project would be expected be circa. 30 weeks.

12.4.3 AIR TO WATER HEAT PUMP

The most efficient and reliable solution for heating the Community School building would be an air to water heat pump. Air-to-water heat pumps, due to their ease and low cost of installation, are both economically viable and environmentally friendly as a renewable alternative to traditional heat generators. With oil prices expected to increase continuously the heat pump will save further in this respect and with the reduced maintenance costs compared to the oil boiler this will shorten the payback period also.
Currently there are radiators with 2 No. oil boilers for heating the building.

12.4.3.1 WHAT ARE HEAT PUMPS

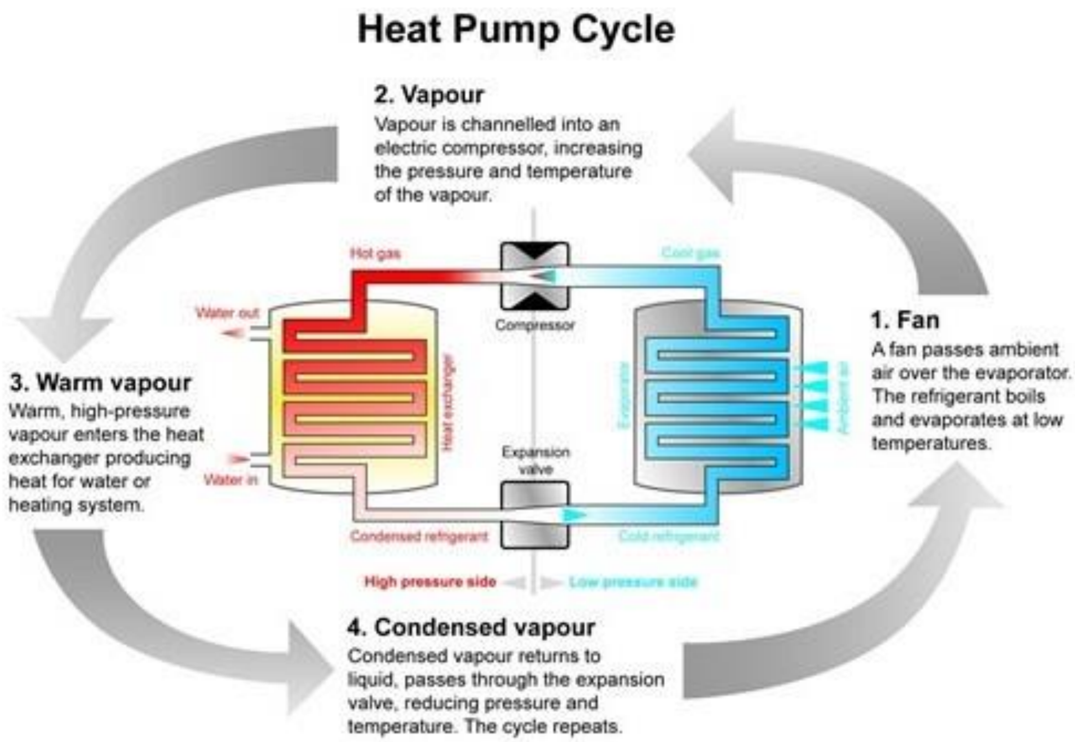
Heat pumps are machines that extract heat from one place, upgrade it to a higher temperature and move it to another place. Heat pumps work by circulating refrigerant liquids between two heat exchanger's with a compressor pump.

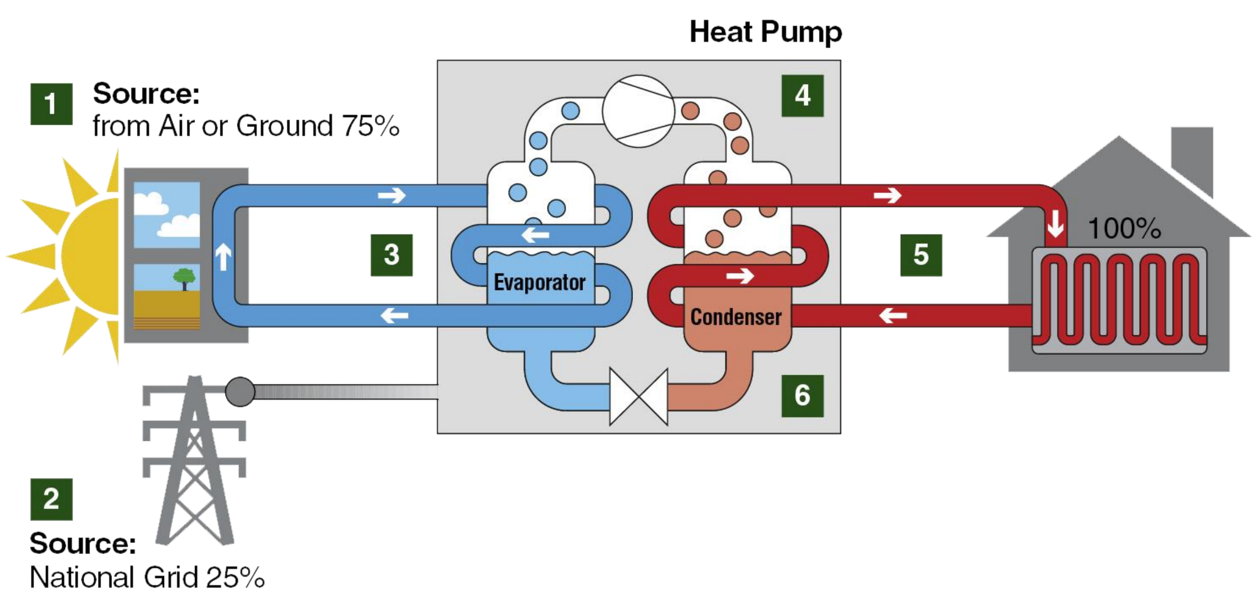
The most common everyday items that use heat pump technology are fridges and freezers. Warm air is extracted from inside these appliances and vented outward. Heat pumps are also used for thermal heating. They extract heat from a heat source but instead of releasing it into the air, like fridges and freezers, they put it into water that circulates through radiators or under-floor heating.

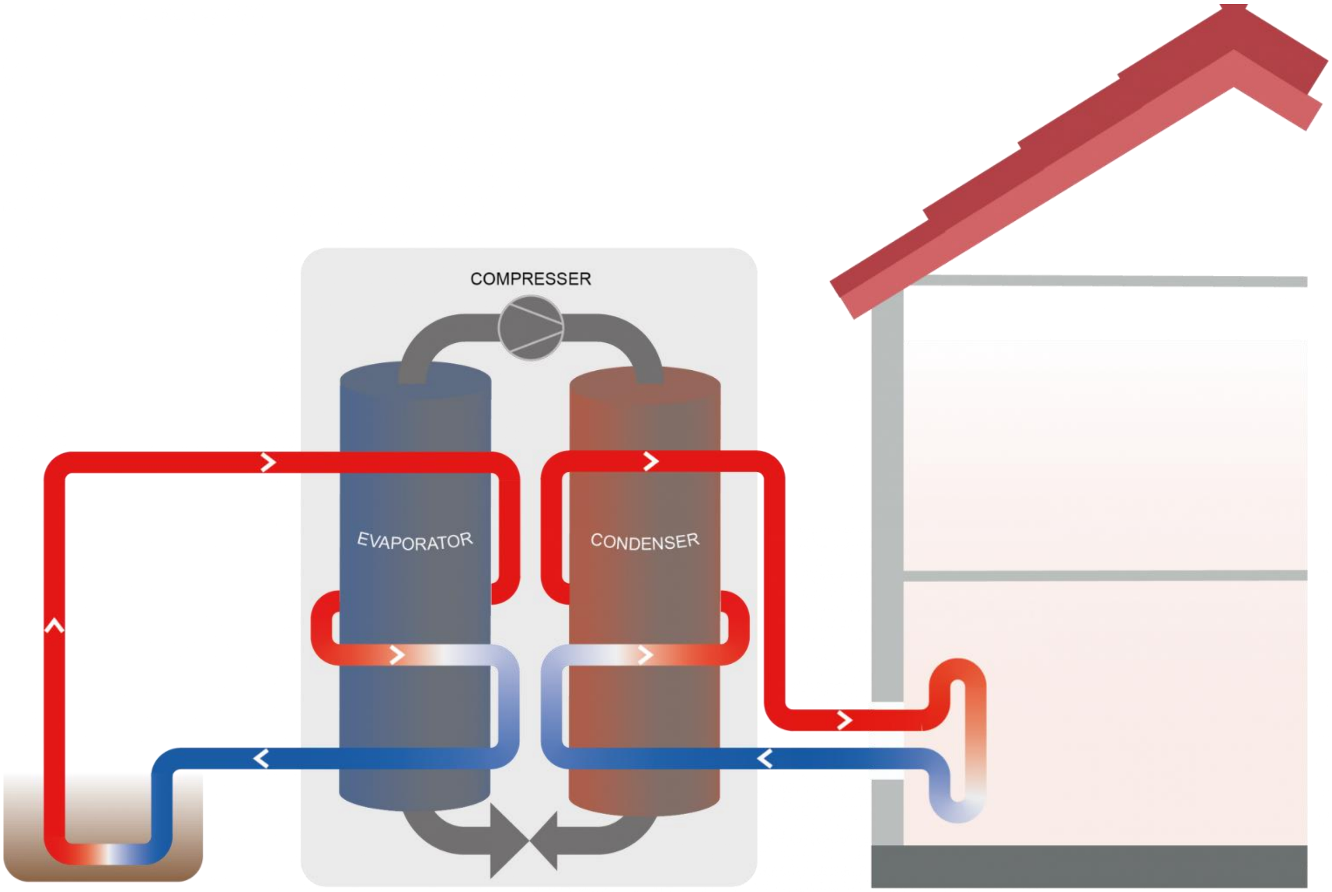
The remarkable thing about heat pumps is that they can extract useful heat from low temperature sources, even down to 20 degrees below freezing.

12.4.3.2 AIR TO WATER HEAT PUMP BENEFITS

An air to water heat pump typically costs 50% to 60% less for heating than a tradition fossil fuel system such as an oil or gas boiler. Put simply the 'efficiency' of an air to water heat pump is from 320% to 400% or more whereas even a condensing boiler has an efficiency of only 92%. This essentially means that for every 4 units of heat put into the building, 3 of those units come free from the outside environment. The main benefit of an air to water heat pump is very high efficiency resulting in low heating costs for the building. Because most of the heat energy supplied to the building is free from nature, there is a very low carbon foot print which gives a better energy rating compared to 'traditional' fossil fuel-based heating systems. The main benefit to you is low running costs for your heating.


Heat Pump Cycle
2. Vapour
Vapour is channelled into an electric compressor, increasing the pressure and temperature of the vapour.
Hot gas
Cool gas
Compressor
Water out
Heat exchanger
Evaporator
Ambient air
Expansion valve
Water in
Condensed refrigerant
Cold refrigerant
High pressure side
Low pressure side
1. Fan
A fan passes ambient air over the evaporator. The refrigerant boils and evaporates at low temperatures.
3. Warm vapour
Warm, high-pressure vapour enters the heat exchanger producing heat for water or heating system.
4. Condensed vapour
Condensed vapour returns to liquid, passes through the expansion valve, reducing pressure and temperature. The cycle repeats.


Heat Pump
1
Source:
from Air or Ground 75%
2
Source:
National Grid 25%
3
4
5
6
Evaporator
Condenser
100%



Air to Water Heat Pump Types
There are essentially two main types of air to water heat pumps, split systems and mono block systems.

A split system air to water heat pump consists of an outside heat exchanger and fan unit and compressor and an indoor unit. The two units are connected by refrigerant pipes. The outdoor unit extracts the heat from the air and passes this heat energy to the refrigerant in the system. The refrigerant is compressed up to a high temperature and is circulated to the indoor unit which has a heat exchanger which takes the high temperature heat from the refrigerant and passes it to the water that circulates to the heating and hot water system.

A mono block air to water heat pump consists of a single outside unit that contains the air to refrigerant heat exchanger, the compressor and the refrigerant to water heat exchanger. In this mono block unit the heat is extracted from the air and passed to the refrigerant, the refrigerant is compressed up to a higher temperature and the heat from the refrigerant is passed to the water that circulates to the heating and hot water system. This outside mono block unit is connected into your house or building by means of two water pipes similar to an outside boiler system.

12.4.4 COSTS AND PAYBACK

The installation of the 36kW Air to Water Heat Pump and the associated works required. The expected costs are €26,500 incl. VAT for the supply and fit.

Item	Annual Savings (€)	Investment (€)	ROI (Years)
36kW Heat Pump	5,538	26,500	4.8

*For a Heat Pump to work in this building it is recommended to upgrade both the ceiling and wall insulation to the standards below, otherwise the heat pump will not efficiently and wouldn't provide the ROI in the table above.

12.4.5 CEILING

There is a pitched roof in Mohill Community College. There is a suspended ceiling in some of the building and other areas there isn't a suspended ceiling. There is currently 150mm ceiling insulation in the rooms with the suspended ceiling.
It is recommended to upgrade the roofs to 300mm of mineral wool insulation to bring it up to current standards, resulting in a u-value of 0.13 W/m2K. The pitched roof should be ventilated to current standards also.

Element	Upgrade	Nett Area (m2)	Thermal Saving (kWh)	Electrical Saving (kWh)	Saving (€)	Capital Cost (€)	Payback Period (Years)
Roofs:							
Pitched Roof	Ceiling Level Insulation	3211	34,342	0	5,495	67,592	12.3

12.4.6 WALLS

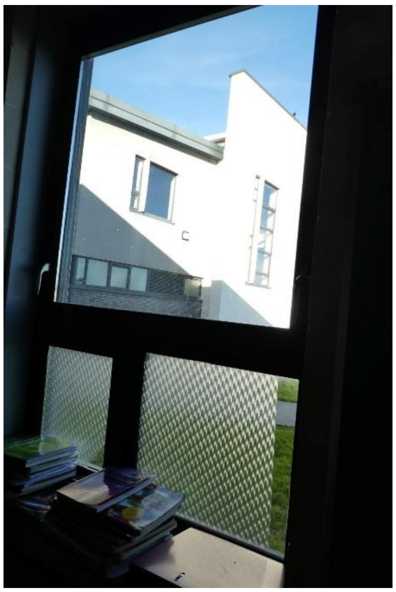
The external walls consist of wall construction, with circa 50mm of EPS insulation in the 100mm cavity. The u-value of the walls is circa 0.6 W/m2K.
It is recommended to install cavity wall insulation into the remainder of the cavities, improving the u-value of the wall to circa 0.3 W/m2K.

The options below highlight the energy saving opportunities;

Element	Upgrade	Nett Area (m2)	Thermal Saving (kWh)	Electrical Saving (kWh)	Saving (€)	Capital Cost (€)	Payback Period (Years)
External Walls:							
Cavity Fill - Partially Filled	Cavity Insulation	2800	86,940	0	5,216	33,600	6.4

12.4.7 WINDOWS AND DOORS

There are 4mm clear double-glazed windows and an electronic sliding entrance door. To make improvements to the windows and doors would be difficult with a short return on investment. The only thing is to make sure seals and hinges are working correctly and should be checked regularly. The existing windows and doors have a u-value of 1.16 $W/m^2 K$.



13 Aurivo Mohill Mart

13.1 Introduction to Renewable Energy

Renewable energy systems are those that tap into the Earth's natural cycles to generate heat or electricity. They do not include fossil fuels (although these are derived from plant matter and, therefore, the sun), but do include biomass (such as timber and energy crops).

13.2 Significant Energy Users

Significant energy users (SEUs) are a key characteristic of energy performance. All types of energy consumed and energy-using plant, equipment, fixtures and fittings within the business were investigated. The different categories of plant and equipment that use energy were identified.

The Significant Energy User categories identified were as follows;

- **Lighting**
- **IT**

13.3 Current Energy Use and Costs

The approx. annual energy use and costs for the business are as follows; 50 units during the day, 68 units at night. 118 kWh on average per day. This is usage is baseload usage.

Fuel	2018	
	Consumption (kWh)	Spend (€ Excl. VAT)
Electricity	43,070	6,029
Total	43,070	6,029

13.4 Opportunities for Renewable Energy

The purpose of this Renewable Energy Feasibility Study was to analyse the effectiveness of technologies related with the production of renewable energy. The goal of this Feasibility Study was to determine which technologies would be more feasible to apply at the business to reduce energy costs and GHG emissions.

The analysis consisted of defining the property, functioning and energy output of each renewable energy technology. From an analysis of the potential renewable energy technologies that would be best suited to building, the following are the Renewable Energy opportunities;

The renewable energy technologies identified were;

- **Solar PV**

Others are only considered if applicable.

13.4.1 SOLAR PV

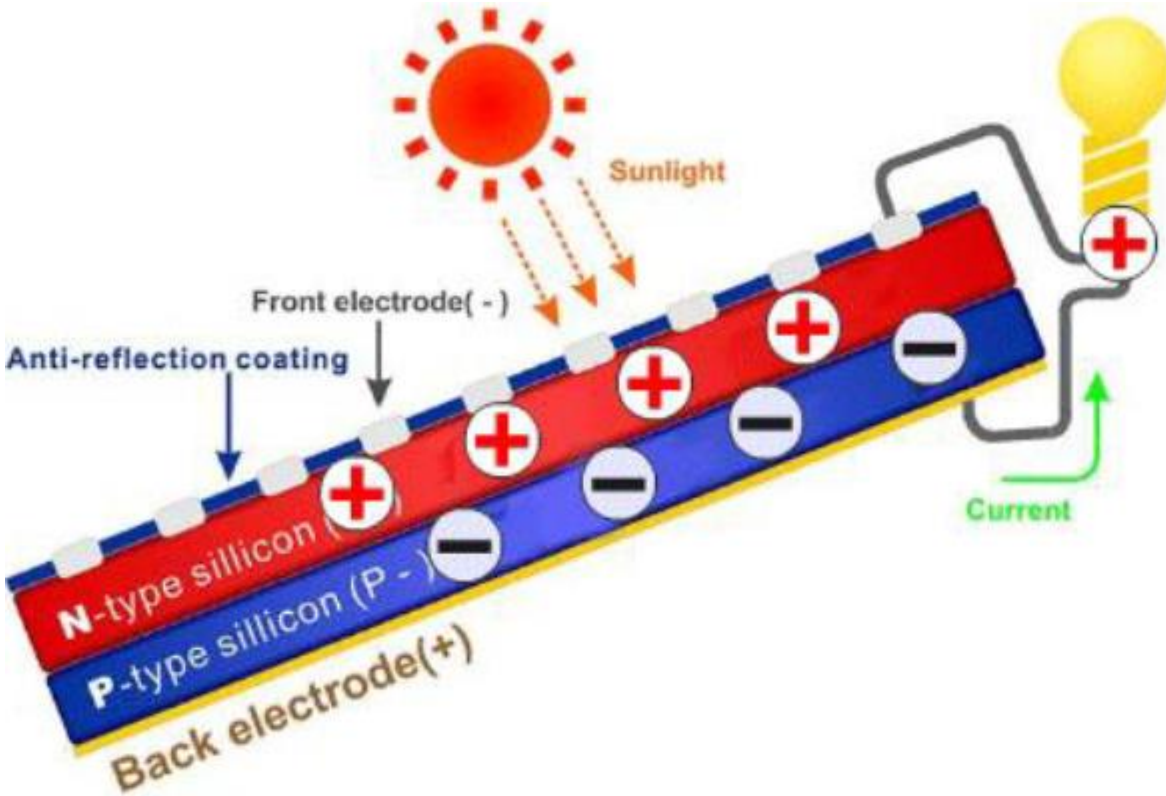
13.4.1.1 BACKGROUND

The sun provides free renewable energy, which makes it one of the most cost-effective solutions compared to traditional resources, such as coal, oil or nuclear power. Furthermore, the sun represents an inexhaustible energy source. Solar energy technologies are characterised by such beneficial features as low running cost, long lifetime, and silent non-polluting energy generation.

Energy from the sun can be harnessed during daylight hours to generate heat or power. Cloud cover does not stop solar energy collection, but at any given moment energy collection is maximised when cloud cover is low, the angle of the sun is high, and the collector is oriented so that it faces the sun. Solar energy is collected and converted using a limited number of broad principles – although there are many variations associated with each.

A photovoltaic or PV module is commonly made from a number of cells connected together in series. In accordance with the spectrum of available light, various materials display varying efficiencies. Therefore, depending on the manufacturing material solar modules are optimised for light absorption prior or beyond the Earth's atmosphere.

Solar panels use light energy from the sun to generate electricity through the photovoltaic effect. Photovoltaic modules or solar panels are made from semiconductor materials, such as silicon. Impurities are added to simulate a doping effect and increase the number of charge carriers within the semiconductor material. When impurities are added, two different layers are created: one of n-type material, which has too many electrons, and one of p-type material, which has too few. Junction between the two layers is known as a p-n junction. This technique is used to manufacture transistors and integrated circuits (silicon chips).



Light consists of packets of energy called photons. Depending on their wavelength, photons are either reflected or absorbed. The energy from the absorbed photons is given to the electrons in the material, which causes some of them to cross the p-n junction. Both cell sides must be connected in order to get a current flow. Current is proportional to the number of absorbed photons and therefore proportional to the light intensity.

13.4.1.2 SOLAR PV OPPORTUNITY

The building is facing west and is not ideally suited for roof mounted Solar PV. However, a ground mounted system could be installed and ideally orientated with a south facing solar array. The principle of achieving a net zero energy building using solar energy will require some tariff to sell export power, as it would not be feasible to match the on-site demand on a seasonal basis. Based on the data below the system is sized to optimise on-site use.

13.4.2 COSTS AND PAYBACK

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
Ground mounted Solar PV	120	295	198	35.40	€52,243	29867	€4,779	10.9

All figures are excl. VAT and capital funding support. Figures include supply & fit and all associated works required.

13.4.2.1 TIMEFRAMES AND PLANNING PERMISSION

Typically, the timeframe for completing Solar PV of 35kW is increased due to planning and also the larger scale of the project. Generally, a valid application will be dealt with by a planning authority in 12 weeks from the date the application is made to the final grant of a permission. However, the period can vary, particularly if the planning authority seeks further information from the applicant (which it should do within the first 8 weeks).

Therefore, the full project would be expected be circa. 30 weeks.

14 Lough Rynn Castle Hotel

14.1 Introduction to Renewable Energy

Renewable energy systems are those that tap into the Earth's natural cycles to generate heat or electricity. They do not include fossil fuels (although these are derived from plant matter and, therefore, the sun), but do include biomass (such as timber and energy crops).

14.2 Significant Energy Users

Significant energy users (SEUs) are a key characteristic of energy performance. All types of energy consumed and energy-using plant, equipment, fixtures and fittings within the business were investigated. The different categories of plant and equipment that use energy were identified.

The Significant Energy User categories identified were as follows;

- **Thermal Heating**
- **Hot Water Heating**
- **Cooking Appliances**
- **Refrigeration**
- **Lighting**
- **IT**

14.3 Current Energy Use and Costs

The approx. annual energy use and costs for the business are as follows;

Fuel	2018	
	Consumption (kWh)	Spend (€ Excl. VAT)
Electricity	683,218	95,650
Gas for Thermal Heating	834,033	50,042
Gas for Hot Water	208,500	12,510
Gas for Cooking	233,400	26,808
Total	1,427,885	185,010

14.4 Opportunities for Renewable Energy

The purpose of this Renewable Energy Feasibility Study was to analyse the effectiveness of technologies related with the production of renewable energy. The goal of this Feasibility Study was to determine which technologies would be more feasible to apply at the business to reduce energy costs and GHG emissions.

The analysis consisted of defining the property, functioning and energy output of each renewable energy technology. From an analysis of the potential renewable energy technologies that would be best suited to building, the following are the Renewable Energy opportunities;

The renewable energy technologies identified were;

- **Solar PV**
- **Air Source Heat Pump**
- **Biomass**

Others are only considered if applicable.

14.4.1 SOLAR PV

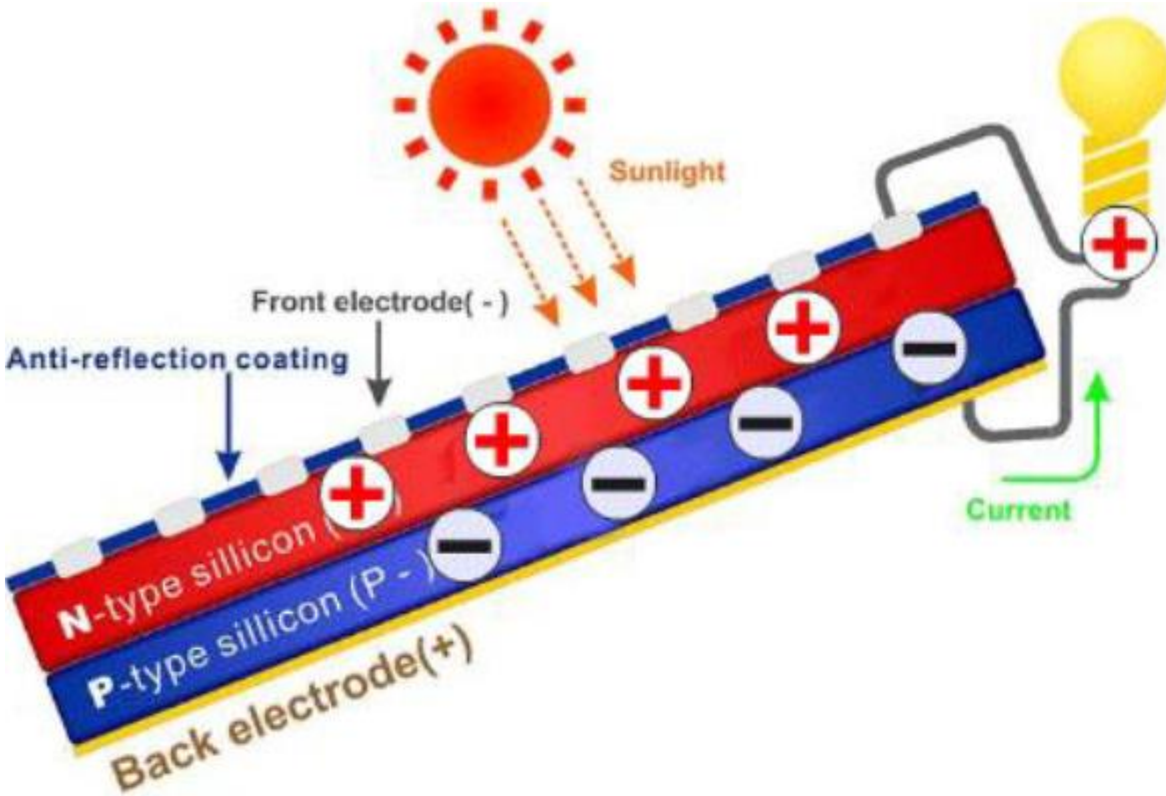
14.4.1.1 BACKGROUND

The sun provides free renewable energy, which makes it one of the most cost-effective solutions compared to traditional resources, such as coal, oil or nuclear power. Furthermore, the sun represents an inexhaustible energy source. Solar energy technologies are characterised by such beneficial features as low running cost, long lifetime, and silent non-polluting energy generation.

Energy from the sun can be harnessed during daylight hours to generate heat or power. Cloud cover does not stop solar energy collection, but at any given moment energy collection is maximised when cloud cover is low, the angle of the sun is high, and the collector is oriented so that it faces the sun. Solar energy is collected and converted using a limited number of broad principles – although there are many variations associated with each.

A photovoltaic or PV module is commonly made from a number of cells connected together in series. In accordance with the spectrum of available light, various materials display varying efficiencies. Therefore, depending on the manufacturing material solar modules are optimised for light absorption prior or beyond the Earth's atmosphere.

Solar panels use light energy from the sun to generate electricity through the photovoltaic effect. Photovoltaic modules or solar panels are made from semiconductor materials, such as silicon. Impurities are added to simulate a doping effect and increase the number of charge carriers within the semiconductor material. When impurities are added, two different layers are created: one of n-type material, which has too many electrons, and one of p-type material, which has too few. Junction between the two layers is known as a p-n junction. This technique is used to manufacture transistors and integrated circuits (silicon chips).



Light consists of packets of energy called photons. Depending on their wavelength, photons are either reflected or absorbed. The energy from the absorbed photons is given to the electrons in the material, which causes some of them to cross the p-n junction. Both cell sides must be connected in order to get a current flow. Current is proportional to the number of absorbed photons and therefore proportional to the light intensity.

14.4.1.2 SOLAR PV OPPORTUNITY

The building is ideally orientated with a south facing roof for a roof mounted solar array. The principle of achieving a net zero energy building using solar energy will require some tariff to sell export power, as it would not be feasible to match the on-site demand on a seasonal basis. Based on the data below the system is sized to optimise on-site use. The Lough Rynn Hotel is in use 7 days a week all year round.

14.4.2 COSTS AND PAYBACK

The portion of the Hotel roof which is south facing and has a potential for Solar PV is approximately 400m^2.

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
Roof mounted Solar PV	120	295	198	35.40	€34,829	29110	€4,075	8.5

Description	No of Panels	Wp	System Size M2	Total System Size (kWp)	Costs excl. VAT	Annual kWh Savings	Annual Cost Savings	ROI
Ground mounted Solar PV	480	295	792	141.60	€208,972	119467	€19,115	10.9

All figures are excl. VAT and capital funding support. Figures include supply & fit and all associated works required.

14.4.2.1 TIMEFRAMES AND PLANNING PERMISSION

Typically, the timeframe for completing Solar PV of 35kW+ is increased due to planning and also the larger scale of the project. Generally, a valid application will be dealt with by a planning authority in 12 weeks from the date the application is made to the final grant of a permission. However, the period can vary, particularly if the planning authority seeks further information from the applicant (which it should do within the first 8 weeks).

Therefore, the full project would be expected be circa. 30 weeks.

14.4.3 AIR SOURCE HEAT PUMP

The most efficient and reliable solution for heating the water in the hotel would be an air to water heat pump. Air-to-water heat pumps, due to their ease and low cost of installation, are both economically viable and environmentally friendly as a renewable alternative to traditional heat generators. An air to water heat pump for heating the water would be the most economical renewable energy that could be implemented in the hotel compared to using the heat pump for space heating as insulation improvements would have to completed in the hotel and this might prove challenging due to aesthetic reasons particularly for wall insulation.

With gas prices expected to increase continuously the heat pump will save further in this respect and with the reduced maintenance costs compared to the oil boiler this will shorten the payback period also.
Currently there are radiators with 20 No. Ferroli gas boilers for heating the building and the water.

14.4.3.1 BACKGROUND

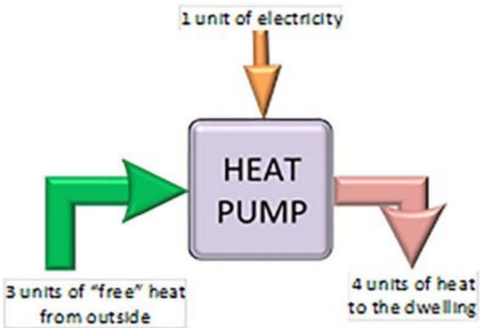
Hot water heat pumps are the cheapest way to heat hot water available in Ireland today. A mature technology in Europe these units are becoming more and more popular in Ireland due to the low installation cost and even lower running costs.

Hot water heat pumps are cheaper to install than solar panels but give the same savings of about 70% reduction in hot water heating costs. They produce hot water all year-round summer and winter maintaining a full tank of hot water at all times.

They work simply by using the waste air within a building and using it to power the heat pump that comes as part of the hot water cylinder. Unlike solar thermal systems there is no need for extensive pipe runs or for any installation of panels on a roof which require weather proofing.

14.4.3.2 AIR TO WATER HEAT PUMP BENEFITS

An air to water heat pump typically costs 50% to 60% less for heating than a tradition fossil fuel system such as an oil or gas boiler. Put simply the ‘efficiency’ of an air to water heat pump is from 320% to 400% or more whereas even a condensing boiler has an efficiency of only 92%.



This essentially means that for every 4 units of heat put into the building, 3 of those units come free from the outside environment.

14.4.3.3 COSTS AND PAYBACK

The heat pump for domestic water for an existing hot water tank is available in two versions: smaller 1.8 kW, appropriate for connecting a 300 liter hot water tank and a bigger 2.8 kW, appropriate for connecting a hot water tank of 400 to 800 liters of water volume.

Item	Annual Savings (€)	Investment (€)	ROI (Years)
Air to water heat pump	2,886	3,800	1.3

14.4.4 HYDRO

A small-scale Hydro generation could be possible for Lough Rynn. Water has been among the chief sources of power for at least 500 years. By 1850, Ireland had around 6,400 watermills, according to the EU-funded SPLASH (Spatial Plans and Local Arrangement for Small Hydro) report.

Water wheels were eventually replaced by turbines and expanding industry came to be served by national and regional power grids. Small hydro sites were abandoned, but now there is renewed interest in the small sector.

As well as their obvious usefulness, something strongly in favour of the small sites is that they have far less impact on the environment the bigger ones. They usually do not require new dams, or reservoirs, and their construction can also allow for the passage of migratory fish. Up to now, the focus in Ireland has been largely on wind power and solar power. But, with both EU and government policies actively encouraging renewable energy sources, we could see more small hydro stations in the years ahead.

Improvements in small turbines and generator technology mean that micro technology (under 100 kW) hydro schemes are an attractive means of producing electricity. There is a potential for Lough Rynn to install a 25kW hydro system to generate electricity for the hotel to use.

It's quite difficult to make generalisations about the cost to build hydro systems because of the different combinations of head (the change in water levels between the intake and discharge) and maximum flow rate, and how that affects the maximum power output and choice of turbine type.

Low Head Hydro-Power Generator

In Ireland small refers to an upper limit capacity of 10MW. Small-scale schemes (under 10MW) are usually operated by private developers and small companies. Hydro power requires the source to be fairly close to the site of power usage or to the national grid. The turbine converts potential energy stored in the flow of water to produce electricity. The lack of a default purchaser of all renewable energy supplied to the network is the main deterrent to developing small-scale hydro generation. ESB fulfilled this function until 1994. Start-up costs are high, but, after the initial pay-back period, the developer is rewarded with power production from a "free fuel" at relatively low operating costs.

14.4.5 COSTS AND PAYBACK

Most of the development cost is determined by the location and site conditions the rest being the cost of manufacturing the electromechanical equipment. Initial costs may be high due to strict environmental regulations. A large proportion of the capital costs are associated with the civil engineering works and, for plants in remote locations, the grid connection charges can also be significant.

The table below is a rough ball-park estimate of typical project costs for systems requiring an 'average' amount of civil engineering works and grid connection upgrades. In all cases it is assumed that good quality hardware is used throughout, which we would recommend anyway if you want a reliable hydro system in the long-term.

Item	Annual Savings (€)	Investment (€)	ROI (Years)
25KW	15,400	205,000	13

Item	Annual Savings (€)	Investment (€)	ROI (Years)
50KW	30,660	361,500	11.8

You'll notice that very small hydropower systems are disproportionately expensive, and this is because hydro projects of any size have to include a substantial fixed-cost element at the design and consenting stages, and to a slightly lesser degree during the installation stage. This is why we generally advise people that to get an economically-viable hydropower system the maximum power output will have to be at least 25 kW, and preferably at least 50 kW. Smaller systems can make sense, particularly at sites with higher heads or if other intangible benefits, such as sustainability, environmental protection or publicity, are valued as much as return on investment.

It is worth mentioning that sometimes intangible benefits can be worth a lot, for example at sites frequented by tourists a small hydro or micro hydro system can add a lot of additional interest as a visitor attraction and in other cases the marketing benefit to a company from being able to say that their energy is generated on site from zero emission hydropower can be significant.

14.4.5.1 PLANNING PERMISSION

It is recommended to commence informal discussions with planning and fishery board authorities early on in the assessment to get a better feeling for their attitude towards the project. The relevant local authority will decide if an Environmental Impact Assessment (EIA) is required. An EIA is carried out at the project proposal stage to determine if an Environmental Impact Statement (EIS) is required. Most proposed small-scale hydro schemes would have an output well below 20 megawatts and may not impound any water. A change in 30% of mean river channel flow is likely to occur and it is in this context that an EIA is required.

15 McCawley Wood Fuels

15.1 Potential use of wood chips to offset oil and gas use in Mohill

Changing to locally available, renewable energy can make significant positive impacts on the reduction of heating costs of local businesses with the thermal load and capacity to utilise wood chip. Critically for the Western Region, renewable energy presents rural communities with opportunities for economic regeneration, creating wealth and employment in rural areas.

As the price of oil and gas continues upwards, it is becoming more and more essential that we look at alternative means of space heating. Wood chip boilers offer a more economical and energy efficient alternative to oil or gas without compromising on the reliability, convenience or automation of traditional systems.

As oil and gas become scarcer and more difficult to extract from the earth, prices are continuing to rise. Also, carbon tax on fossil fuels is likely to rise and rise as government policies continue to encourage a move from fossils and towards renewable energy. This policy is necessary to meet EU directives for a reduction in carbon emissions. All this means that renewable energy is quickly becoming the norm.

Background to Wood Chip Boilers

There are a number of wood chip boilers on the market one of them as an example is the Gilles Boiler, the boilers which are 93% efficient can be fed automatically which means less hassle and less mess. All augers have solid steel shafts to prevent breaking making the Gilles wood chip boilers extremely durable with a product life of over 20 years.

The appliance will determine the wood chip used (quality, size, moisture content). Output is usually (much) larger than 30 kW. The wood chip market is currently developing rapidly. Domestic-scale wood chip heating systems require a chip moisture content of approx. 25% by preference. Larger systems can handle moisture levels of 35 to 45%.

Chips can be delivered in large 1/2 tonne bags or by using a tractor/trailer combination or a bin lorry. Chips can be tipped into a bunker, delivered into a silo or in a stockpile in the corner of a shed. Size of storage space will depend on heat requirements, fuel delivery frequency and moisture content.

Due to the storage volume requirements many of the local businesses wouldn't have space to have a storage area for the wood chips or access for delivery.

There is an opportunity in Mohill to utilise McCawley wood fuels to supply the following local businesses and also a District Heating System.

15.2 Mohill Community School

15.2.1 CURRENT ENERGY USE AND COSTS

The approx. annual energy use and costs for the school are as follows;

Fuel	2018	
	Consumption (kWh)	Spend (€ Excl. VAT)
Electricity	103,827	16,916
Oil	243,199	19,383
Total	347,026	36,299

15.2.2 WOOD CHIP OPPORTUNITY

Wood chip boilers are scientifically tested to ensure they achieve very high efficiency levels of up to 93%. This means very little heat is lost during combustion. In contrast, most traditional oil and gas heating systems only achieve around 80% efficiency and this can be significantly lower (as low as 60%) if a boiler is old or hasn't been serviced regularly.

Note: If the standard oil boiler is eg. 80% efficient, that means that for every €100 spent on oil, only €80 is reaching the building as heat with the remaining €30 gone up the chimney or flue.

Mohill Community School could consider switching from the 2 No. Ferroli oil boilers to wood chip. A woodchip boiler could be installed to operate from September to April which would meet the peak demand of thermal and water heating.

An above ground woodchip silo could be installed alongside the existing boiler room where the chips could be delivered by tipping trailer into a reception bin and then blown into the silo using a fan.

Item	Wood chip consumption	Annual Savings (€)	Investment (€)	ROI (Years)
150KW Wood chip boiler	58 tonnes per year	12,600	75,000 (excludes 30% grant) Net cost: €58,000	4.6

15.3 Lough Rynn – Wood Chip

15.3.1 CURRENT ENERGY USE AND COSTS

The approx. annual energy use and costs for the business are as follows;

Fuel	2018	
	Consumption (kWh)	Spend (€ Excl. VAT)
Electricity	683,218	95,650
Gas for Thermal Heating	834,033	50,042
Gas for Hot Water	208,500	12,510
Gas for Cooking	233,400	26,808
Total	1,427,885	185,010

The Hotel's annual thermal and water heating costs are €62,552 with 1,042,533 kWh as the usage.

15.3.2 WOOD CHIP OPPORTUNITY

Wood chip boilers are scientifically tested to ensure they achieve very high efficiency levels of up to 93%. This means very little heat is lost during combustion. In contrast, most traditional oil and gas heating systems only achieve around 80% efficiency and this can be significantly lower (as low as 60%) if a boiler is old or hasn't been serviced regularly.

Note: If the standard oil boiler is eg. 80% efficient, that means that for every €100 spent on gas, only €80 is reaching the building as heat with the remaining €30 gone up the chimney or flue.

Lough Rynn could consider switching over a section of the hotel to wood chip and consider woodchip for the proposed extension which would consist of a leisure centre and bedrooms.

Item	Wood chip consumption	Annual Savings (€)	Investment (€)	ROI (Years)
350KW Wood chip boiler	250 tonnes per year	32,500	142,500 (excludes 30% grant) Net cost: €110,000	3.3

15.4 Mohill Family Support Centre

15.4.1 CURRENT ENERGY USE AND COSTS

The annual energy use and costs for the Mohill Family Resource Centre is as follows;

Energy Type	kWh / Annum	Cost (ex VAT)
Electricity	12,600	€2,142
Oil (Kerosene)	31,446	€2,751

15.4.2 WOOD CHIP OPPORTUNITY

Wood chip boilers are scientifically tested to ensure they achieve very high efficiency levels of up to 93%. This means very little heat is lost during combustion. In contrast, most traditional oil and gas heating systems only achieve around 80% efficiency and this can be significantly lower (as low as 60%) if a boiler is old or hasn't been serviced regularly.

Note: If the standard oil boiler is eg. 80% efficient, that means that for every €100 spent on oil, only €80 is reaching the building as heat with the remaining €30 gone up the chimney or flue.

Mohill Family Support Centre could consider switching from the 1 No. oil boiler to wood chip. A 12kW woodchip boiler could be installed to operate from September to April which would meet the peak demand of thermal heating.

An above ground woodchip silo could be installed alongside the existing boiler room where the chips could be delivered by tipping trailer into a reception bin and then blown into the silo using a fan. The silo capacity should be able to store 5 tonnes of woodchips at 28% moisture content.

Item	Wood chip consumption	Annual Savings (€)	Investment (€)	ROI (Years)
12KW Wood chip boiler	7.5 tonnes per year	1,850	12,000 (excludes 30% grant) Net cost: €9,230	4.9

15.5 Notes